2 APRIL 2018

Project-Specific Quality Assurance Project Plan
PFAS Preliminary Assessment/Site Inspection

Joint Base Lewis-McChord

Pierce County, Washington

Joint Base Lewis-McChord Public Works – Environmental Division
IMLM-PWE
MS 17 Box 339500
Joint Base Lewis-McChord, Washington 98433

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QAPP Worksheet #1 -- Title and Approval Page

Project-Specific Quality Assurance Project Plan (QAPP), PFOS/PFOA Preliminary Assessment/Site Inspection Joint Base Lewis-McChord, Washington

April 2, 2018

Prepared for
Joint Base Lewis-McChord Public Works-Environmental Division
IMLM-PWE
MS 17 Box 339500
Joint Base Lewis-McChord, Washington 98433

Prepared by
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Prepared under
U.S. Contract No. W912DQ-15-D-3011
Task Order W912DW17F2085

Approval Signatures:

Meseret Ghebresllassie/JBLM IR Program Manager	Date
William Graney/USACE Seattle District Project Manager	Date
Gregory T. Burgess/AECOM Project Manager	Date
Dora Chiang/AECOM PFAS Technical Lead	Date

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Executive Summary

On behalf of the Joint Base Lewis-McChord (JBLM) Public Works Environmental Division IMLM-PWE, under contract to the U.S. Army Corps of Engineers (USACE), Seattle District, AECOM Technical Services, Inc. (AECOM) will conduct a Site Inspection (SI) for Per- and Poly-fluoroalkyl substances (PFASs) at Joint Base Lewis-McChord (JBLM) located in Pierce County, Washington. The goal of the SI is to identify PFAS source areas that are currently impacting groundwater production wells at the installation. In 2016, the U.S. Environmental Protection Agency (U.S. EPA) issued a Drinking Water Health Advisory Level (HAL) of 70 parts per trillion (ppt) for the combined concentration of two specific PFAS compounds, (PFOS) Perfluorosulfonic acid and Perfluorooctanoic acid (PFOA).

PFAS compounds are present in Aqueous Film Forming Foam (AFFF), which is used for the training of and extinguishing petroleum fires. PFAS compounds are also used in the manufacturing of intermediary products and hundreds of articles of commerce used in electronics, aerospace/defense, building/construction, alternative energy, automotive, semiconductors, military, healthcare, outdoor apparel/equipment, chemical/pharmaceutical manufacturing.

Data collection for a Preliminary Assessment (PA) was performed to identify potential source areas at JBLM to support the sampling effort described herein.

The PA comprised:

The findings of the PA are summarized in Worksheet #10. Based on the PA data collection, 52 potential source areas were identified. These potential sources can generalize as:

- Fire training areas
- Fire-fighting equipment testing areas
- Hangars with AFFF Systems
- AFFF storage areas
- Emergency response equipment
- Landfills
- Processes that used products potentially containing PFAS compounds

Source areas were prioritized for sampling based on the following:

- Historical/anecdotal information for largest AFFF release volumes
- Proximity to impacted production wells
- Areas with most direct pathway to impacted production wells

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ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
AEC	Army Environmental Command
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
amu	atomic mass unit
ARFF	airport rescue fire fighting
bgs	below ground surface
BRH	Bush, Roed and Hitchings
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	chain of custody
CSM	conceptual site model
DL	detection limit
DO	dissolved oxygen
DoD	U.S. Department of Defense
DOH	[Washington] State Department of Health
DOT	Department of Transportation
Ecology	Washington State Department of Ecology
ELAP	Environmental Laboratory Approval Program
EPA	[U.S.] Environmental Protection Agency
HAL	health advisory level
HPLC/MS/MS	high pressure liquid chromatography/tandem mass spectrometry
ICAL	initial calibration
ICV	initial calibration verification
IDW	investigation-derived waste
IR	Installation Restoration
IRP	Installation Restoration Program
ISC	instrument sensitivity check
JBLM	Joint Base Lewis-McChord
LCS	laboratory control sample
LM	Lewis Main
LOD	limit of detection
LOQ	limit of quantitation
MB	method blank
MDL	method detection limit
MF	McChord Field
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicate
MTCA	Model Toxics Control Act
NA	not applicable
NAVD	North American Vertical Datum
NE	not established
NEtFOSAA	n-ethyl perfluorooctanesulfonamidoacetic acid
NFA	No Further Action
NFRAP	No Further Remedial Action Planned

1	NMeFOSAA	n-methyl perfluorooctanesulfonamidoacetic acid
2	ORP	oxidation reduction potential
3	PA	preliminary assessment
4	PFAS	poly- and perfluoroalkyl substances
5	PFBS	perfluorobutanesulfonic acid
6	PFC	perfluorinated compound
7	PFDA	perfluorodecanoic acid
8	PFDoA	perfluorododecanoic acid
9	PFHpA	perfluoroheptanoic acid
10	PFHxS	perfluorohexanesulfonic acid
11	PFHxA	perfluorohexanoic acid
12	PFNA	perfluorononanoic acid
13	PFOA	perfluorooctanoic acid
14	PFOS	perfluorosulfonic acid
15	PFTA	perfluorotetradecanoic acid
16	PFTrDA	perfluorotridecanoic acid
17	PFUnA	perfluoroundecanoic acid
18	PID	photoionization detector
19	PM	Project Manager
20	PRQL	project-required quantitation limit
21	ppt	parts per trillion
22	PQL	project quantitation limit
23	PVC	polyvinyl chloride
24	QA	quality assurance
25	QAO	Quality Assurance Officer
26	QAPP	Quality Assurance Project Plan
27	QC	quality control
28	QSM	Quality Systems Manual
29	RPD	relative percent difference
30	RSL	regional screening level
31	SOP	standard operating procedure
32	SPE	solid-phase extraction
33	TPP	technical project planning
34	UCMR	Unregulated Contaminant Monitoring Rule
35	UFP-QAPP	Uniform Federal Policy for Quality Assurance Plan
36	USACE	U.S. Army Corps of Engineers
37	WAC	Washington Administrative Code

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QAPP Worksheet #2 -- QAPP Identifying Information

Site Name/Number: Joint Base Lewis-McChord
Contractor Name: AECOM Technical Services, Inc. (AECOM)
Contract Number: W912DQ-15-D-3011
Contract Title: PFOS/PFOA CERCLA Site Inspection
Joint Base Lewis McChord, Washington
Task Order: W912DW17F2085

1. This Quality Assurance Project Plan (QAPP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Project Plans (*UFP-QAPP*)* (EPA 2012) and *Guidance for Quality Assurance Project Plans (*EPA QA/G-5*)* (EPA 2002).

2. Regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3. This is a project-specific QAPP.

4. Organizational partners (stakeholders) and connection with lead organization: Joint Base Lewis-McChord (JBLM), Environmental Protection Agency (EPA), Region 10 (Stakeholder), Washington Department of Ecology (Ecology), and Washington Department of Health (DOH). This group collectively comprises the Technical Project Team.

5. Lead organization: JBLM Installation Restoration Program (IRP)

6. Contracting agency: U.S. Army Corps of Engineers (USACE) Seattle District

6. If any required QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion below:

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	
2	QAPP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
Project Organization		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	Information to be provided in Health and Safety Plan and Accident Prevention Plan

QAPP Worksheet #2 -- QAPP Identifying Information (Continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
Project Planning/Problem Definition		
9	Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background. Site Maps (historical and present)	
11	Site-Specific Project Quality Objectives/Systematic Planning Process Statements	Refers reader to Worksheets #12, #15, #17, and #18
12	Field Quality Control Samples	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	
14	Summary of Project Tasks	Refers reader to Worksheets #12, #16, and #17
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale Sample Location Maps	Refers reader to Worksheet #12
18	Sampling Locations and Methods/SOP Requirements Table	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	
Analytical Tasks		
23	Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving, and Disposal	
27	Sample Custody Requirements	
Quality Control Samples		
28	Laboratory QC Samples Table	Refers reader to Worksheet #12
Data Management Tasks		
29	Project Documents and Records Table	
30	Analytical Services Table	Refers reader to Worksheets #11 and #18
C. Assessment Oversight		
31	Planned Project Assessments Table	
32	Assessment Findings and Corrective Action Responses	
33	QA Management Reports Table	
D. Data Review		
34	Verification (Step I) Process Table	

QAPP Worksheet #2 -- QAPP Identifying Information (Continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
35	Validation (Steps IIa and IIb) Process Table	Refers reader to Worksheet #12
36	Validation (Steps IIa and IIb) Summary Table	Refers reader to Worksheets #12, #18, and #24
37	Usability Assessment	Refers reader to Worksheets #11 and #12

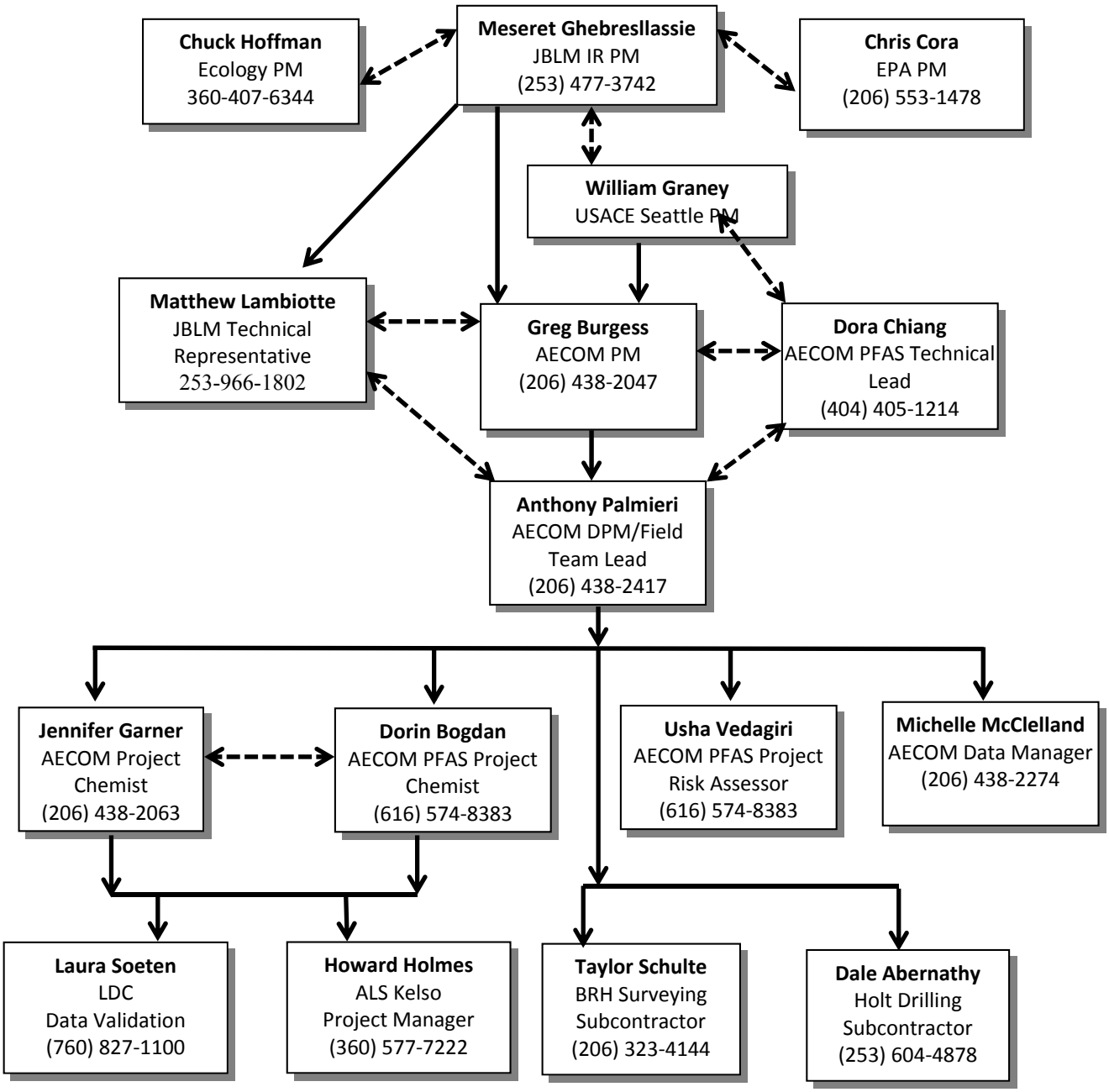
QAPP Worksheet #3 -- Distribution List

Name of QAPP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number (Optional)
William Graney	Project Manager (PM)	USACE Seattle District	206-764-3494	William.P.Graney@usace.army.mil	
Meseret Ghebresllassie	Installation Restoration (IR) PM	JBLM	253-477-3742	meseret.c.ghebresllassie.civ@mail.mil	
Chris Cora	PM	EPA	206-553-1478	cora.christopher@epa.gov	
Chuck Hoffman	PM	Ecology	360-407-6344	chof461@ecy.wa.gov	
Steve Hulsman	Chemical Water Quality Monitoring Program	Washington DOH	253-395-6777	steve.hulsman@doh.wa.gov	
Matthew Lambiotte	Field Technical Representative	JBLM	253-966-1802	matthew.j.lambiotte.ctr@mail.mil	
Greg Burgess	PM	AECOM	206-438-2047	greg.burgess@aecom.com	
Dora Chiang	PFAS Technical Lead	AECOM	404-405-1214	dora.chiang@aecom.com	
Anthony Palmieri	Deputy PM/Field Team Lead	AECOM	206-438-2417	anthony.palmieri@aecom.com	
Howard Holmes	PM	ALS Kelso	360-577-7222	howard.holmes@alsglobal.com	
Dale Abernathy	Driller	Holt Services	253-604-4878	dabernathy@holtservicesinc.com	
Taylor Schulte	Surveyor	Bush, Roed and Hitchings (BRH) Surveying	206-323-4144	taylors@brhinc.com	
Laura Soeten	Data Validator	Laboratory Data Consultants (LDC)	760- 827-1100	lsoeten@lab-data.com	

QAPP Worksheet #4 -- Project Personnel Sign-Off Sheet

Name of QAPP Recipients	Title/Role	Organization	Telephone Number (Optional)	Signature/ E-mail Receipt	QAPP Sections Reviewed	Date QAPP Read
William Graney	PM	USACE Seattle District	206-764-3494			
Meseret Ghebresllassie	IR PM	JBLM	253-477-3742			
Greg Burgess	PM	AECOM	206-438-2047			
Dora Chiang	AECOM PFAS Program Manager	AECOM	404-405-1214			
Amy Dahl	Quality Assurance Officer (QAO)	AECOM	206-438-2261			
Jennifer Garner	Project Chemist	AECOM	206-438-2063			
Anthony Palmieri	Deputy PM/Field Team Lead	AECOM	206-438-2417			

QAPP Worksheet #5 -- Project Organizational Chart



Lines of Authority
Lines of Communication

QAPP Worksheet #6 -- Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/ or e-mail	Procedure
Changes in scope or costs Authorization	USACE Seattle District Contracting Officer (KO)	Mike Miyagi	206.764.3266 Michael.m.miyagi@usace.army.mil	All changes in scope or costs require written approval from the USACE KO through coordination with USACE PM to the AECOM PM.
Technical approach to changes in scope or costs	USACE Seattle District PM	William Graney	206-764-3494 William.P.Graney@usace.army.mil	Discuss and approve all technical aspects of changes to scope or budget with AECOM PM prior to submitting to USACE KO for approval.
Regulatory agency interface	JBLM Installation Restoration Program Manager	Meseret Ghebresllassie	253-477-3742 meseret.c.ghebresllassie.civ@mail.mil	All changes to scope/procedures in the QAPP must be submitted to the JBLM PM via telephone, e-mail, or in writing. The JBLM will notify stakeholders as appropriate, direct AECOM, and submit changes to the USACE Seattle PM and KO as appropriate.
Field progress reports	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Periodic progress and schedule updates will be provided to JBLM PM and USACE PM via e-mail and telephone.
Stop work due to safety issues	AECOM Field Team Lead	Anthony Palmieri	206-438-2417 anthony.palmieri@aecom.com	Changes in site safety conditions that result in a stoppage of work will be communicated to the JBLM and USACE PM via telephone, e-mail, or in writing as soon as recognized.
Changes prior to field/laboratory work	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Changes in project conditions that result in changes to the QAPP, overall project scope, or costs will be communicated to the JBLM and USACE PM via telephone, e-mail, or in writing as soon as recognized.

QAPP Worksheet #6 -- Communication Pathways (Continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/ or e-mail	Procedure
Changes in the field	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Changes in project conditions that result in changes to the QAPP, overall project scope, or costs will be communicated to the JBLM PM via telephone, e-mail, or in writing as soon as recognized.
Field corrective actions	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Corrective actions necessary to resolve field conditions not specified in the QAPP will be communicated to JBLM PM via telephone, e-mail, or in writing as soon as recognized.
Sample receipt variances	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Sample receipt conditions that result in a variance from those described in the QAPP will be communicated to the JBLM PM via telephone, e-mail, or in writing as soon as recognized.
Reporting laboratory quality variances	AECOM Project Chemist	Jennifer Garner	206-438-2063 jen.garner@aecom.com	Preliminary notification of issues affecting data quality will be communicated to the AECOM PM via telephone or e-mail as soon as recognized.
Analytical corrective actions	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Notification of corrective actions implemented to resolve issues affecting data quality will be communicated to the JBLM PM by the AECOM PM within 48 hours of identification via e-mail or telephone. Overall data usability will be documented in the submittal to JBLM.

QAPP Worksheet #6 -- Communication Pathways (Continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/ or e-mail	Procedure
Reporting data validation issues	AECOM PFAS Project Chemist	Dorin Bogdan	616-574-8383 dorin.bogdan@aecom.com	Preliminary notification of issues affecting data quality will be communicated to the AECOM PM via telephone or e-mail as soon as recognized.
Data validation corrective actions	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Notification of corrective actions implemented to resolve issues affecting data quality will be communicated to the JBLM PM by the AECOM PM within 48 hours of identification via e-mail or telephone. Overall data usability will be documented in the submittal to JB LM and USACE.
Results of work	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Reports documenting project work will be submitted to the JBLM and USACE PM in accordance with the Statement of Work.

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
William Graney	PM	USACE Seattle	• Perform project Contract management on behalf of USACE. • Ensure that project scope of work is accomplished. • Oversee project budget and schedule. • Provide direction to the AECOM team according to USACE's contracting process
Meseret Ghebresllassie	Installation Restoration Program Manager	JBLM	• Lead Project Manager on behalf of JBLM. • Responsible for interaction with agencies and stakeholders. • Provide direction to the AECOM team according to Army Restoration Program Technical Guidance. • Act as lead interface with agencies and stakeholders.
Matthew Lambiotte	Field Technical Representative	JBLM	• Provide oversight of the contractor's activities and ensure compliance with this QAPP. • Escort and facilitate access to investigation areas at JBLM.
Greg Burgess	PM	AECOM	• Submit field sampling standard operating procedures (SOPs) to USACE for approval. • Coordinate work of AECOM and subcontractor personnel, ensuring that all adhere to project administration and technical requirements. • Monitor and report the progress of work, ensuring that project deliverables are completed on time and within budget. • Monitor budget and schedule, notifying the JBLM and USACE PMs of any changes that may require administrative action. • Ensure adherence to contract quality requirements, project scope of work, and quality control (QC) plans. • Ensure that all work meets the requirements of the technical specifications and complies with applicable codes and regulations. • Ensure that all work is conducted in a safe manner in accordance with the site safety and health plan. • Serve as the primary contact between JBLM, USACE, and AECOM staff for actions and information related to the work, and includes appropriate technical personnel in decision making. • Coordinate satisfactory resolution of nonconformances.

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table (Continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Dora Chiang	PFAS Technical Lead	AECOM	• Establish and maintain the QC program. • Oversee program QC, including chemical data acquisition. • Work directly with contractor and USACE/JBLM staff to ensure implementation of the program QC plans. • Act as focal point for coordinating quality matters and resolving quality issues across all projects. • Suspend project activities if quality standards are not being maintained. • Interface with USACE/JBLM on quality-related matters. • Perform reviews of audit reports prepared by others.
Amy Dahl	Project QAO	AECOM	• Provide and maintain effective QC system for all project tasks. • Monitor QC activities to ensure conformance with authorized policies and procedures and recommend improvements as necessary. • Conduct site meetings covering QC requirements where appropriate. • Perform reviews, inspections, and audits of AECOM and subcontractor activities to ensure QC procedures are being followed. • Identify and resolve nonconformances in accordance with the requirements of the QC procedures. • Stop work or require re-performance of any nonconformances resulting from improper application of prescribed procedures. • Maintain awareness of the entire project to detect conditions that may be adverse to quality. • Track corrective actions for conditions adverse to quality, verify documentation of corrective actions, and close out documentation upon completion. • Concur on nonconformance report dispositions and maintain system for tracking and analyzing reports. • Function as liaison with JBLM, USACE, and AECOM QC personnel.
Anthony Palmieri	Deputy PM/Field Team Lead	AECOM	• Manage and supervise field activities.

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table (Continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Anthony Palmieri	Site Safety and Health Officer	AECOM	• Oversee all aspects of safety. • Document site conditions. • Ensure that all work is conducted in accordance with the QAPP. • Provide direction to field staff and subcontractors.
Jennifer Garner / Dorin Bogdan	Project Chemist / Project PFAS Chemist	AECOM	• Provide direction to laboratory and data validator. • Oversee uploading of data to data management system. • Check electronic data for completeness.
Howard Holmes	PM	ALS Kelso	• Review and implement analytical laboratory elements of this QAPP. • Manage laboratory analytical chemists to complete the sample analyses selected in this QAPP, according to the approved methods. • Monitor, review, and document the quality of all analytical chemistry work performed by laboratory under this QAPP. • Oversee management of analytical data. • Transmit completed data packages to the AECOM Project Chemist. • Promptly inform the AECOM Project Chemist of any laboratory analytical problems, data quality issues, or delays in sample analysis. • Promptly respond to any data quality issues identified through the independent data validation process.
Laura Soeten	Data Validator	LDC	• Review and validate laboratory chemical analytical data to assess compliance with method requirements and the project requirements. • Assign data qualifiers as appropriate. • Submit a validation report indicating assignment of qualifiers and reasons for qualification.

QAPP Worksheet #8 -- Special Personnel Training Requirements

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel/ Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/ Certificates
Sample collection	AECOM Internal PFAS Sampling Guidance and Training Seminar	AECOM	Prior to April 2018	All field and project management staff	AECOM	AECOM
Health and safety	HAZWOPER 40-hour safety training and annual 8-hour refresher	Various for 40 hr and AECOM for annual 8-hour refresher	Prior to April 2018 or must be current with 8-hour refresher	All field staff and project manager	AECOM	AECOM

QAPP Worksheet #9 -- Project Scoping Session Participants Sheet

Two Technical Project Planning (TPP) meetings were conducted with the following entities:

- USACE Seattle District
- U.S. Army Environmental Command (AEC)
- JBLM
- EPA, Region 10
- Ecology
- Washington DOH

This group collectively comprises the Technical Project Team.

The following are summaries of these meetings.

TPP #1 was held on December 6, 2017, to discuss the overall project approach, including the following:

1) Discuss PFOS/PFOA source assessment/identification scope.
2) Develop consensus on PFOS/PFOA source area investigation prioritization criteria.
3) Develop consensus on analyte list.
4) Provide the Technical Project Team with a preliminary assessment of current site conditions based on existing data.
5) Provide the Technical Project Team an overview of existing data.
6) Develop consensus on Phase I monitoring well sampling locations.
7) Develop consensus on path forward to identify potential PFOS/PFOA source areas.

Attendees included representatives from USACE, AEC, JBLM, EPA, Ecology, and DOH.

TPP #2 was held on February 14, 2018, to address the following:

1) Discuss and review the overall project approach.
2) Review the status of the source assessment/identification effort and prioritize the potential source that had been identified to date.
3) Establish the QAPP question.
4) Select locations for Phase I sample collection and analysis.

Attendees included representatives from USACE, AEC, JBLM, EPA, Ecology, and DOH.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model

Background

Per- and polyluoroalkyl substances (PFAS) are manufactured fluorinated organic chemicals that have been used in a wide variety of industrial and commercial products due to their valuable properties, which include fire resistance; dust suppression; and oil stain, grease, and water repellence. Examples of uses include carpets and furniture fabric, clothing, anti-stick surfaces for preparing and packaging food, dust suppression for metals plating, as well as polishes, waxes, and cleaning products. PFAS, including Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA), are also components of aqueous film forming foam (AFFF), a firefighting foam used by industry and the U.S. Department of Defense (DoD) since 1970 to fight petroleum fires.

PFAS are a class of hundreds of compounds that contain chains of various lengths of fluorine-carbon bonds. Fluorine-carbon bonds are one of the strongest bonds in nature; therefore, these compounds have distinct properties of strength, durability, heat-resistance, and stability. PFAS compounds are used in the manufacturing of intermediary products and hundreds of articles of commerce used in electronics, aerospace/defense, building/construction, alternative energy, automotive, semiconductors, military, healthcare, outdoor apparel/equipment, chemical/pharmaceutical manufacturing, and most notably in AFFF used for fire training and firefighting.

PFAS are persistent in the environment and have been found in surface water, soil, and groundwater. While consumer products and food are the primary uses of PFAS containing materials, drinking water is identified as the primary exposure pathway that can cause health concern. Such contamination is typically local and associated with a specific facility where the chemicals were produced, used to manufacture other products, or used for firefighting or firefighting training.

In May 2016, the U.S. EPA issued a Lifetime Health Advisory Level (HAL) level in drinking water of 70 parts per trillion (ppt; or 0.07 micrograms per liter [µg/L]) for PFOS/PFOA (individually or combined if both are detected in drinking water). EPA's HAL levels include a significant margin of safety to ensure they are protective of the most sensitive sub- populations while drinking the water over a lifetime. The EPA HAL levels are based on the effects of PFOS and PFOA on laboratory animals and epidemiological studies of human populations.

As part of the Army's commitment to supplying quality drinking water to its service members, family members, and civilians and in response to the HAL released by EPA, the Army implemented a comprehensive PFOS and PFOA testing program at the Army facilities that may have used AFFF or other PFOS/PFOA products..

QAPP Worksheet #10 – Problem Definition (Continued)

On June 10, 2016, the Department of Army instructed all Army installations to conduct PFAS contamination assessments for known fire training areas, AFFF storage locations, hangars/buildings with AFFF suppression systems, fire equipment maintenance areas, and areas where emergency response operations required AFFF use as possible source areas. On August 29, 2016, an Army Guidance Memo for conducting PFAS assessments was finalized and included guidance on sample design and the specific sampling and analysis methods that should be used in PFAS-related site investigations (U.S. Army 2016). On February 20, 2018, an Army Guidance Memo was issued that requires PFAS assessments to include the 14 analytes that EPA Method 537 can identify (U.S. Army 2018).

At JBLM (Figure 10-1), AFFF was used for firefighter training at several locations on the east side of McChord Field's runway, near Lewis Main's Gray Army Airfield, and North Fort Lewis through the early 1990's. The hangar AFFF systems and accident response fire-fighting vehicles currently contain 8 carbon chain (C8) AFFF. The stockpiles of C8 AFFF have been replaced AFFF that is not C8. JBLM identified up to eleven historic fire training areas that could be the potential source for the production well impacts. These AFFF fire suppression systems are also potential source areas for PFOS/PFOA.

JBLM water systems are tested routinely in accordance with the Safe Drinking Water Act. When PFAS at Air Force installations around the country became an issue in April 2016, JBLM proactively began testing its drinking water sources for PFOS and PFOA. JBLM conducted an initial test of 23 production wells across the base, including one at Yakima Training Center and three at the former Umatilla Army Depot in Oregon, for which JBLM is the caretaker.

JBLM began testing water from the 23 production wells on the installation. Testing results between January and April 2017 confirmed the presence of PFAS compounds in five drinking water wells on JBLM exceeding the EPA HAL of 70 ppt. These wells and results are:

- North Well, McChord Field (MF) – 216 ppt
- South Well MF – 250 ppt
- Well #17, Lewis-Main (LM) 71 ppt
- Housing Well II (MF) – 72 ppt
- Golf Course Well #22 – 78 ppt

These well locations are shown on Figures 10-2 and 10-3. All five wells were isolated, or already shut-off for other reasons, with water distribution for JBLM McChord Field and Lewis-Main/North adequately supplied by other wells that met the EPA HAL. On 31 May 17, point-of-use filtration devices were installed at the Golf Course Clubhouse and Well#22 was turned back on feeding only the clubhouse."

The geologic units within JBLM and the surrounding area consist primarily of Pleistocene-age glacial deposits. These units comprise a complex system of stacked aquifers and confining units, which include the following:

QAPP Worksheet #10 – Problem Definition (Continued)

Upper Vashon Aquifer (A1): Vashon Drift (Steilacoom gravel, recessional outwash). Material consists of stratified sand, silt and gravel, thickness of 35 feet to >200 feet.

Confining Unit (A2): Vashon Drift (Vashon Till, ice contact, moraine and glaciolacustrine deposits). Material consists of clay, silt, sand and gravel, discontinuous/not present in places; can provide a conductive pathway between Upper Vashon Aquifer and Lower Vashon Aquifer; thickness ranges from a thin veneer to 150 feet on a regional scale.

Lower Vashon Aquifer (A3): Vashon Drift (advance outwash). Material consists of well-sorted sand or sand and gravel with silt and clay lenses; average thickness is 75 feet.

Confining Unit (B): Olympia Beds (Kitsap Formation), Lawton Clay. Material consists of primarily of silts and clays; thickness of 10-20 feet where present on JBLM; discontinuous/not present in places; can provide a conductive pathway between Vashon Aquifers and lower Sea Level Aquifer.

Sea Level Aquifer (C): Salmon Springs Drift, Penultimate Drift, Hayden Creek Drift, and Wingate Hill Drift (glacial drift). Materials consist of sand and gravel, pebble to cobble gravel, with minor lenses of silt, clay, till, and volcanic ash; thickness of 50 to 100 feet.

Confining Unit (D): Puyallup Formation. Material consists of alluvial and lacustrine sand, silt, clay, and occasional volcanic ash; average thickness is 100 feet.

Stuck Aquifer (E): Stuck Drift. Material consists primarily of silt, sand, and gravel with discontinuous till and lacustrine deposits; thickness ranges from a thin veneer to >200 feet below ground surface (bgs).

Confining Unit (F): Alderton Formation. Consists primarily of silt and clay, with minor lenses of sand and gravel; thickness ranges from 50 feet to > 300 feet.

Orting Aquifer (G): Orting Drift. Material consists primarily of stratified sand and gravel with discontinuous layers of till.

At this time, there is very little information to develop a specific conceptual site model (CSM) relative to each impacted production well area. There is site-specific data at multiple locations across JBLM. However, most of this is related to site-specific investigations for non-PFAS impacts. Information for potential PFAS source areas is generally limited to less than 40 feet bgs, which precludes development of a CSM to describe how PFAS reaches the deeper production well screen intakes. The general geology and hydrogeology is known. Groundwater flow in the aquifers described above is primarily to the west/northwest, with the exception of the Sea Level Aquifer in the vicinity of the JBLM Logistics Center, where it has a south/southwest flow and then west to west-northwest flow near American Lake (Figure 10-2).

QAPP Worksheet #10 – Problem Definition (Continued)

There are areas identified as potential sources of PFAS due to surface releases. Source of PFAS and the mechanisms by which PFAS compounds migrate to the impacted production wells needs to be evaluated.

Problem Statement

Six production wells have detected concentrations of PFOS/PFOA above the EPA HAL of 70 ppt.

Preliminary Assessment (PA) Data Collection – Potential PFAS Source Identification

Preliminary assessment data were collected to identify potential PFAS sources at JBLM and support prioritization of potential sources and selection of sampling locations. The primary objectives of the PA were:

1. Identify operations/activities, both current historic, of potential concern for potential contributions of PFOS/PFOA to drinking water production wells identified with PFAS concentrations at or exceeding HAL of 70 ppt
2. Identify potential pathways of PFAS to the environment
3. Prioritize potential source areas for Site Investigation

Source prioritization criteria were:

- Historical/anecdotal information for largest AFFF release volumes
- Proximity to impacted production wells
- Areas with most direct pathway to impacted production wells

The PA focused on AFFF storage and use (e.g. fire-fighting training areas, hangars fire suppression systems, crash/accident sites, accidental system releases or spills). Based on experience, other products/activities of interest included:

- Landfills
- Waterproofing operations
- Surfactant operations (e.g. vehicle wash, laundries)
- Dry wells (stormwater)

The PA screened for operations and areas of concern and focused on areas centered on obvious higher activity. The screening was based on:

- Fire-fighting training
- Areas with identified concerns based on map review

QAPP Worksheet #10 – Problem Definition (Continued)

- Spills
- Dry wells (stormwater)
- Known contaminated sites

The PA source identification tasks included:

- Interviews with Department of Public Works, environmental, and Public Safety personnel
- Reviewed historical information such as accident responses, aerial photographs, and other documentation
- Reviewed databases and sources:
  - P2 Enterprise, Environmental, Safety, Occupational Health- Management Information System
  - Spill Response Incident Reporting
  - Aircraft accidents
- Information from environmental programs
  - SWPPP – outfalls, dry wells
  - Safety – AFFF system locations
- Visual site inspections
  - Visits to potential areas of concern
  - Interview personnel at or associated with areas of concern

Research Summary

Interviews identified that operations apparently using the highest volume of chemicals typically containing PFAS, were fire extinguishing systems that utilized AFFF. Systems associated with AFFF storage / use at JBLM included aircraft hangars equipped with fire suppression systems and emergency response equipment. Each of the aircraft hangars equipped with fire suppression systems typically included one aboveground storage tank containing AFFF located in a mechanical room with associated pumps and piping. Piping distributes the AFFF to nozzles or deluge outlets mounted at strategic locations in the hangar interior, sometimes floor-mounted, sometimes ceiling mounted, and sometimes on structural members between the floor and ceiling.

Interviews also identified that the most significant discharge of AFFF directly to the environment likely was during firefighting training exercises and during routine adjustment of the foam spray patterns of Airport Rescue Fire Fighting (ARFF) vehicles. The fire-fighting training exercises occurred in areas located at McChord Field to the east of the runway, at Gray Field on the northeast portion of the airfield, and approximately 0.25-miles to the southeast of Gray Field. The routine adjustment of the foam spray patterns of ARFF vehicles occurred by spraying foam

QAPP Worksheet #10 – Problem Definition (Continued)

onto areas including flight-line areas on and around the perimeter of runways at McChord, and washing the resultant foam off the runways to adjacent permeable areas.

Other products/activities of interest include:

- Landfills - LF 13 received soil excavated from FT032. A number of landfills received municipal wastes which could be PFAS sources. Lewis LF 5 includes storm water infiltration.
- Waterproofing – Historic canvas waterproofing operations were identified in the western portion of Ft. Lewis and in the Fort Lewis Logistics Center and could be a PFAS source.
- Surfactant operations (e.g. vehicle wash racks, laundries,)
    - Current and historic vehicle wash racks were identified at McChord airfield and at Fort Lewis south of Gray Field
    - Historic laundries were identified in the western portion of Fort Lewis and in the Fort Lewis Logistics Center
- Dry wells (stormwater) – the majority of the current dry wells are located in residential and office building areas. However, dry wells were located surrounding one fire station where AFFF has been utilized on ARFFs, and historically dry wells may have been located in or near more industrial areas.

Table 10-1 presents a summary of the identified potential PFAS sources at JBLM.

Site MF-FT-27 – McChord Field

Site MF-FT-27 is a former fire training area covering less than 1/4 acre, located along the north end of the main runway, east of the east taxiway and west of the perimeter road. Waste JP-4 and gasoline were used as fuels for fire training exercises at the site from 1960 to 1977. The fire training area did not contain a liner; however, the fuels reportedly floated on water before being ignited. Site MF-FT-27 is located on the upgradient side of the base. Twenty-four fire training exercises were conducted each year using about 300 gallons of fuel for each exercise (1982 CH2M Hill Installation Restoration Program Records Search). Ecology conducted an Initial Investigation at this site in November 1990. MF-FT-27 was included in the 27 February 1992 Consent Decree. A Site Hazard Assessment under the terms of the Consent Decree was conducted in 1993. Six sampling pits were excavated to a depth of 5 feet and soil samples were analyzed for petroleum products (1995 USAF Phase II Field Summary Report). Fuel contaminated soil was found in two of the pits, and about 6,000 cubic yards of contaminated soil was removed and treated at an on-base bioremediation/landfarming facility.

Following the removal, an examination of historic information, site inspections, and analytical results reveal that residual fuel remaining at this site will not adversely impact human health or the environment. An Air Force Decision Document was issued 25 August 1993, which

QAPP Worksheet #10 – Problem Definition (Continued)

recommended No Further Action (NFA) for this site (1993 USAF IRP NFA DD). Ecology concurred with the recommendation on 28 June 1995.

Site MF-FT-28 McChord Field

Site MF-FT-28 is a former fire training area covering less than 1/4 acre. It was located north of the hazardous cargo loading/unloading area and west of the perimeter road. The site was used for helicopter fire training for one to two years during the early 1960s. The Installation Restoration Program (IRP) Records Search stated that 40 to 50 fire training exercises were conducted during each year using flammable liquids such as JP-4 (1982 CH2M Hill Installation Restoration Program Records Search). Ecology conducted an Initial Investigation at this site in November 1990 and the site was listed in the 27 February 1992 Consent Decree.

Historic information, site inspections, and analytical results reveal that no potential contaminants reportedly released at this site will adversely impact human health or the environment. There are no contaminant pathways connecting the site to human or environmental receptors.

Air Force issued a NFA Decision Document on 25 in August 1993 (1993 USAF IRP NFA DD). Ecology issued NFA concurrence letters for MF-FT-28 on January 27, 1994 and June 28, 1995.

Site MF-FT-29 - McChord Field

Site MF-FT-029 was reportedly a fire training area located approximately 1,200 feet northeast of the confluence of Clover Creek and Morey Creek between the perimeter road and the east base boundary. The general area is covered with regularly mowed native grasses. There is no Air Force knowledge or evidence of site use apart from its listing on old base maps. There is no evidence of environmental contamination emanating from this site (1982 CH2M Hill Installation Restoration Program Records Search).

Based on an examination of historical information, it is likely that this site was mis-identified on old base maps. Inspections of the site did not indicate fire training activities. A NFA Decision Document was issued on 10 July 1990 (1990 USAF IRP NFA DD). Ecology concurred on 12 December 1990.

Site MF-FT-30 McChord Field

Site MF-FT-30 was an old fire training area covering less than 1/4 acre. The site was located southeast of the hazardous cargo loading/unloading area between Morey Pond and Clover Creek on the base. The site was used from approximately 1955 to 1960. The IRP Records Search stated that 35 fire training exercises were conducted each year using approximately 300 gallons of fuel for each exercise. Fuel and used solvents were floated on water before being ignited for the fire training exercises. The site did not have a soil liner (1982 CH2M Hill Installation Restoration Program Records Search).

QAPP Worksheet #10 – Problem Definition (Continued)

Ecology conducted a Model Toxics Control Act (MTCA) Initial Investigation at this site on 16 November 1990 and requested confirmation sampling to determine if either a Site Hazard Assessment or No Further Remedial Action Planned (NFRAP) under MTCA was appropriate.

An examination of historic information, site inspections, and analytical results revealed that the contaminants reportedly released at this site are not adversely impacting human health or the environment. There are no contaminant pathways connecting the site to human or environmental receptors. No rationale can be identified for further investigation at this site. The Air Force concluded the site is finished and should be included within the base wide LTM program. A Decision Document was written in August 1993, which recommended NFRAP for this site (1993 USAF IRP NFA DD).

Site MF-FT-31 McChord Field

Site MF-FT-31 was an old fire training area that covered less than 1/4 acre. The site was located south of the hazardous cargo loading/unloading area on the south side of Morey Pond. Fire training exercises were conducted at the site from 1950 to 1955. The IRP Records Search stated that 30 exercises were conducted each year using approximately 300 gallons of fuel for each exercise. Fuel and other flammable liquids such as solvents were floated on water before being ignited for the training exercise. The site did not contain a soil liner (1982 CH2M Hill Installation Restoration Program Records Search).

A MTCA Initial Investigation was conducted at this site in 1993 and carcinogenic polynuclear aromatic hydrocarbons (PAHs) were found above MTCA cleanup levels. PAHs are insoluble and have been established at other locations on base to present no threat to surface or ground water. There are no contaminant pathways connecting the site to human or environmental receptors. No rationale can be identified for further investigation at this site. The Air Force concluded the site is finished and should be included within the base wide LTM program. A Decision Document was written in August 1993 recommending NFRAP for FT-31 (1993 USAF IRP NFA DD). Ecology concurred that the site does not warrant further investigation because of the non-mobile nature of the contaminants. WDOE NFA concurrence letter for FT-31 signed June 28, 1995.

Site MF-FT-32 McChord Field

Site MF-FT-32 is located 500 feet south of Morey Creek and 500 feet inside the base eastern boundary. The fire training area was built in 1975 and use of the site discontinued in April 1990. Approximately 300 to 400 gallons of waste aviation fuel were used in each exercise. The fire training area consisted of a 130-ft diameter diked, pit lined area with a 1-ft-thick impermeable clay lift. Jet fuel was delivered to the pit from a tank through a gravity sprinkler system to minimize spill potential. The pit drained through an oil/water separator into a holding tank and discharged to the sanitary sewer connected to the Publicly Owned Treatment Works at Fort Lewis (1982 CH2M Hill Installation Restoration Program Records Search).

QAPP Worksheet #10 – Problem Definition (Continued)

A Site Hazard Assessment under the terms of the Consent Decree with Ecology was conducted in 1993. Three test pits were excavated and soil samples were collected. All fuel-contaminated soil (6,000 cubic yards) discovered was removed and treated at an on-base landfarming facility (1997 USAF Fire Training Area Management Plan Addendum). During the excavation of soil, an UST was discovered and removed. During the removal of the tank, a fuel release occurred. Soil was removed at the location of the spill to a depth of 20 ft. Soils excavated from the FT-32 area were reportedly relocated to LF 13, approximately 0.2 mile south of FT 032, thereby creating an AOC at LF13 (see discussion below). Confirmational soil samples were taken from below the UST and seven other locations across the pit. No fuel was detected in any of the samples. A Decision Document was written in August 1990, which indicated the site was finished and should be removed from further IRP consideration (1993 USAF IRP Response Action Carried Out at Site FT-32).

The new/current Fire Training Area FT-32 is constructed over the former Fire Training Area, and utilizes propane instead of jet fuel or other flammables/combustibles. The current Fire Training Area was permitted and is a regulated site. The training area pit now drains into an adjacent holding pond, and after inspection of the discharge and confirmation AFFF was not used, discharges to the sanitary sewer connected to the Publicly Owned Treatment Works at Fort Lewis.

Site MF-FT-33- McChord Field

Site MF-FT-33 is a former fire training area located adjacent to the current Fire Station House 105/Building 6. Fire training exercises were conducted at Site 33 from the late 1940s until 1950, when the overall airfield was much smaller than the current airfield. AVGAS was the primary fuel used during fire suppression training. Approximately 20 training exercises were conducted each year, and 100 to 200 gallons of aviation fuel were burned during each event. No information is available concerning soil seals or a water float. Small quantities of waste fuel were reportedly burned at the site and migration from the site was possible (1982 CH2M Hill Installation Restoration Program Records Search). The Air Force investigated the site and determined that this site posed no significant contamination threat and published a NFRAP Decision Document on 25 August 1993 (1993 USAF IRP NFA DD). Ecology notified the Air Force on 28 June 1995 that the site is identified as no further action/no further remedial action planned and published on the Hazardous Site List to inform the public that McChord remediated the site consistent with the Model Toxics Control Act, and that in its current setting the site no longer presents a danger to public health and is being monitored for environmental compliance.

Landfill 13 LF-13

Site LF-13 is an old landfill located on the up gradient of east side of the 700 feet southwest of the east gate and approximately 300 yards east of perimeter road. The site was used as landfill from 1950 until 1979. Open burning was reported to have occurred during the 1950's (1982 CH2M Hill Installation Restoration Program Records Search).

QAPP Worksheet #10 – Problem Definition (Continued)

Currently the site covered with an engineered bioremediation facility. A 1990 site investigation was conducted using geophysical survey, soil gas survey, installation of three soil borings and 10 monitoring wells. Soil and groundwater samples were tested and all the analytical results were below the MTCA cleanup levels except TCE and daughter products detected slightly above cleanup level in both soil and groundwater samples. In 1993 the site was covered by an engineered and maintained bioremediation facility for fuel-contaminated soils excavated from other IRP sites, including soils excavated from MF-FT-27 and MF-FT-32. The facility has a 40 mil base of geo-fabric base upon which approximately 1.5 to 2.0 feet of fuel-contaminated soil has been placed. When the contaminated soils are fully bioremediated, the facility will either be dismantled or the remediated soil will be seeded with grass and used as permanent cap for the landfill (1993 USAF IRP NFA DD). Since soils from an FT 32 were moved to this location, it is an area of concern for PFAS which may have been leached from the bioremediation/landfarming facility.

Fire Training Pit FTLE17

Former Fort Lewis Fire Training Pit known as FTLE17 is located adjacent to the north side of Taxiway No. 2 at Gray Army Airfield. The FTLE17 is in a large, shallow swale approximately six feet below the elevation of the adjacent taxiway. A few yellow tires and remnants of a low berm (approx. 1.5 feet high) delineate the perimeter of the approximately 100 foot diameter pit. Between 1962 and 1982, the FTLE17 was used for air-crash rescue operation training. Waste materials including duplicating fluid, alcohol, paint thinner, and JP-4 were pumped into the pit and ignited as a fuel source. Records do not indicate whether or not all fluids pumped into the pit were consumed by burning (1993 USACE Multi-Site Limited Field Investigation Management Plan). In September of 1987, three borings were advanced to a depth of 10 feet. Eight soil samples were collected and analyzed for SVOCs, VOCs, pesticides and polychlorinated biphenyls, dioxins, and dioxin homologs. Trace amounts of dioxins, xylenes, methylene chloride, and some SVOCs were detected in some of the samples (U.S. Army 1990).

In 1993 three monitoring wells were installed to the depth of 40 bgs and groundwater samples were analyzed for SVOCs, VOCs, pesticides, polychlorinated biphenyls, dioxins, dioxin homologs and metals. All sample results were below their respective screening criteria and no evidence of groundwater contamination was observed (1995 USACE Multi-Site Limited Field Investigation Report). The location of FTLE17 is currently covered by a concrete surface and is part of a multi-acre aircraft ramp.

Based on their use as fire training areas, these sites are potential PFAS source areas.

Visual Site Inspections

The PA identified hangars at McChord Airfield and Gray Field that currently have, or historically have had, AFFF fire extinguishing systems. These hangars include McChord Hangars 1-7, 9-10, and 13; and Gray Field hangars 3063, 3098, 3106 and 3146; and temporary building 3099. Releases were identified at a number of the hangars by a variety of sources:

QAPP Worksheet #10 – Problem Definition (Continued)

- Review of a spills database
- Reported by JBLM staff that escorted AECOM during our visits to the hangars, or staff that were interviewed after the visit
- During the visits site visits, ongoing small-scale releases of AFFF were also observed.

AFFF fire extinguishing systems have been activated and foam released at McChord Hangars 4 and 6. The release at Hangar 4 was approximately 3,000 gallons and the foam accumulated to a depth of approximately 20 feet on the hangar floor. The release of foam at Hangar 6 accumulated to a depth of approximately three feet on the hangar floor.

AFFF reservoirs in mechanical rooms have had releases occur, during which AFFF concentrate flowed to surrounding floor surfaces and in some cases discharged to floor drains, believed to be connected to the sanitary sewer system. These releases of foam concentrate occurred at McChord Hangars 7 and 13; and Gray Field hangars 3063, 3098, 3106 and 3146; and Gray Field temporary building 3099. The volume of concentrate released ranges from one pint at hangar 3063 mechanical room to 1,500 gallons at McChord Hangar 13 mechanical room.

Two ongoing apparently low volume slow releases were observed during the visual site inspection at Hangars 6 and 10. Work orders regarding these observed releases were submitted to JBLM Public Works. Public Works responded immediately to the work orders.

QAPP Applicability

This QAPP prescribes the sampling requirements to be implemented during the Phase I well sampling and Phase II well installation and sampling. An amendment to this QAPP will be prepared for the Phase II sampling based on the Phase I sampling results. The amendment will be tables and figures to identify specific drilling locations for new wells and additional existing well sampling.

QAPP Worksheet #10 – Problem Definition (Continued)

1 **Table 10-1**
2 **Summary of Potential PFAS Source Areas**

Area Name	Site Number/ Potential Area of Concern	General Location	Potential Concern
McChord - Firefighting Training (FT) Area FT 032 Main/Current FT Area	FT 032	McChord - East side of runway, near Clover Creek	Historic use of AFFF for firefighting practice
McChord – Historic FT Areas Located North of FT 032	FT 027 - 031	McChord - East side of runway, north of FT 032	Historic use of AFFF for firefighting practice
McChord - Landfill 013	LF 013	McChord - East side of runway, approximately 800 feet south of FT 032	Disposal of soils excavated from FT032
McChord – Historic FT Area 033 Fire Station #105 / Building J00006	FT 033	McChord – Area of Building J00006	Historic use of AFFF for firefighting practice Storage of bulk AFFF, and refilling of ARFFs; Test application of AFFF spray pattern onto flight line. Dripping to interior floor surface was observed from AFFF AST inside fire station. garage.
McChord - Clover Creek	Clover Creek	McChord – Crosses via culvert beneath middle of runway, and then flows on surface towards northwest, extending to west boundary of JBLM, many outfalls to creek that have collected storm water from McChord airfield.	Receiving of storm water from hangars equipped with AFFF systems, and historic AFFF releases
McChord - Hangars 1 and 2	Hangars 1 and 2 Buildings J00001 and J00002	McChord - West of central portion of runways	AFFF systems, and releases of AFFF to adjacent surfaces
McChord - Hangars 3 and 4	Hangars 3 and 4 Buildings J00003 and J00004	McChord - West of central portion of runways	AFFF systems, and releases of AFFF to adjacent surfaces. System activation release in 2012 of approximately 3,000 gallons, foam accumulated 20 feet deep in hangar. System activations also possibly in 2008, 2010, 2012 & 2013, release volume unknown.
McChord – Historic Wash Rack / Taxiway D	Historic wash rack and Taxiway D	McChord – Northwest of Hangar 2	Historic use of surfactants at Wash Rack / ARFF vehicles foam spray pattern testing at Taxiway D

QAPP Worksheet #10 – Problem Definition (Continued)

Table 10-1 (continued)
Summary of Potential PFAS Source Areas

Area Name	Site Number/ Potential Area of Concern	General Location	Potential Concern
McChord - Hangar 5	Hangar 5 Building 1178	McChord - Northwestern portion	AFFF systems, and releases of AFFF to adjacent surfaces
McChord - AFFF Sump between Hangars 5 and 6	McChord AFFF Sump between Hangars 5 and 6	McChord – Protrudes from underground between Hangars 5 and 6	Potential release of AFFF from sump
McChord - Hangar 6	Hangar 6 Building 1160	McChord - Northwestern portion	AFFF systems, and releases of AFFF to adjacent surfaces. System activation release in 2009, foam was approximately 3 feet deep in hangar. System activation was reportedly due to freezing temperature conditions. Release from the system of an unknown volume of AFFF in 2011.
McChord - Hangar 7	Hangar 7 Building 1164	McChord - Northwestern portion	AFFF systems, and releases of AFFF to adjacent surfaces. AFFF concentrate release in 2010 of approximately 5 to 10 gallons to mechanical room.
McChord - Hangar 9	Hangar 9 Building 1166	McChord - Northwestern portion	AFFF systems, and releases of AFFF to adjacent surfaces
McChord - AFFF Sump between Hangars 9 and 10	McChord AFFF Sump between Hangars 9 and 10	McChord – Located underground between 9 and 10	Potential release of AFFF from sump
McChord - Hangar 10	Hangar 10 Building 1167	McChord - Northwestern portion	AFFF systems, and releases of AFFF to adjacent surfaces. Dripping to interior floor surface was observed from AFFF AST inside hangar.
McChord Flight line Infield – 4 Aviation Fuel Tanks	McChord Flight line Infield – 4 Aviation Fuel Tanks	McChord – Four bulk fuel tanks located within infield east of Hangars 9 & 10	Potential use of AFFF for firefighting, and release to surrounding environment
McChord - Hangar 13	Hangar 13 Building 1174	McChord - Northwestern portion	AFFF systems, and releases of AFFF to adjacent surfaces. AFFF concentrate release in 2017 of approximately 50 gallons to mechanical room. AFFF concentrate release in approximately 2016 of approximately 1,500 gallons to mechanical room.

QAPP Worksheet #10 – Problem Definition (Continued)

Table 10-1 (continued)
Summary of Potential PFAS Source Areas

Area Name	Site Number/ Potential Area of Concern	General Location	Potential Concern
McChord - AFFF Sump West of Hangar 13	McChord AFFF Sump West of Hangar 13	McChord – Located underground West of Hangar 13	Potential release of AFFF from sump
McChord – Hangar 301	Hangar 301 McChord Field	McChord – South end, west side of McChord Field runway	AFFF systems, and releases of AFFF to adjacent surfaces
McChord – Aircraft Accident Responses	McChord – Aircraft Accident Responses	Along the McChord field runway, from north end to south end, and beyond in approach zones	Potential use of AFFF for firefighting, and release to surrounding environment
McChord – Main Bulk Fuel Tank Farm	McChord – Main Bulk Fuel Tank Farm	West of North Well	Potential use of AFFF for firefighting, and release to surrounding environment
Gray Field - SWMU #47	SWMU #47 Historic Firefighting Training Area	Ft Lewis – Southeast of Gray field, west of wash rack	Historic Firefighting Training Area
Gray Field - Wash Rack	Equipment 3559 - 3562	South of Gray Field - near SWMU-47	Surfactants
Gray Field – Hangar 3101	Hangar 3101	Northeast Portion of Gray Field	AFFF system, and releases of AFFF to adjacent surfaces
Gray Field - National Guard Hangar	Hangar 3106	Ft Lewis –NE corner of Gray Field	AFFF system, and releases of AFFF to adjacent surfaces. AFFF concentrate release in approximately 1985 of unknown volume to mechanical room.
Gray Field - FTLE-17	FTLE-17	Ft Lewis – Within NE portion of Gray Field flight line, approximately 600 feet northwest of Hangar 3146, beneath 10” thick concrete helicopter ramp (parking)	Historic Fire Training Area
Gray Field - Hangar 3146	Hangar 3146	Ft Lewis – Within NE portion of Gray Field, south of larger Hangar 31010 (31010 is very new hangar)	AFFF system , and releases of AFFF to adjacent surfaces. AFFF concentrate release in 2001 of approximately 10 gallons to mechanical room.
Gray Field - Army Reserve Hangar	Hangar 3273	Ft Lewis – SE Portion of Gray Field, East of Flight Line	AFFF system , and releases of AFFF to adjacent surfaces
Gray Field – Storm water Drainage Swale near Hangar 3273	Storm water Drainage Swale near Hangar 3273	Approximately 500 feet southwest of Hangar 3273	Receives storm water from near hangar equipped with AFFF System
Gray Field – Storm water Drainage Swale near Hangar 3146	Storm water Drainage Swale near Hangar 3146	Approximately 200 feet southwest of Hangar 3146	Receives storm water from near hangar equipped with AFFF System

QAPP Worksheet #10 – Problem Definition (Continued)

Table 10-1 (continued)
Summary of Potential PFAS Source Areas

Area Name	Site Number/ Potential Area of Concern	General Location	Potential Concern
Gray Field – Hangar 3098	Hangar 3098	West side of Gray Field	AFFF system, and releases of AFFF to adjacent surfaces. AFFF concentrate release in 2008 of approximately 250 gallons to mechanical room.
Gray Field – Building 3095, AFFF system for Hangar 3098	Building 3095	West side of Gray Field	AFFF system , and releases of AFFF to adjacent surfaces
Gray Field – Building 3099	Building (Temporary) 3099	Gray Field – along flight line on west side	AFFF release reportedly occurred inside of an aircraft. Reported AFFF release of 500 gallons to the inside of an aircraft.
Gray Field – Hangar 3063	Hangar 3063	Gray Field – along flight line on west side	AFFF system, and releases of AFFF to adjacent surfaces. Reported AFFF release of one pint in 2009.
Gray Field - Fire Station 102 – Bldg 3081	Fire Station 102 – Bldg 3081	Gray Field – along flight line on west side	AFFF bulk storage in adjacent outbuilding AFFF storage and refilling
Gray Field – Landfill #1	Gray Field – Landfill #1	Gray Field – approximately 1,000 feet west of SW Corner of Gray field	Potential leaching of PFAS compounds to groundwater
Ft. Lewis - Buildings 04074 & 04076	Buildings 04074 & 04076	West part of Ft Lewis – SW of Traffic Circle	Historic canvas waterproofing
Ft. Lewis - LF #9 (and #10)	LF #9 (and #10)	West part of Ft Lewis – I-5 Interchange, Exit 118, south and north of I-5	Potential leaching of PFAS compounds from landfill contents to groundwater
Ft. Lewis – Bldg 1401 - Formerly known as Bldg 1402	Building 1401 - Formerly known as Bldg 1402 Historic Laundry operation since 1941	West part of Ft Lewis – South of I-5 near Exit 119/ Dupont Gate	Historic use of surfactants at laundry operation
Ft. Lewis - Fire Station 1 – Bldg 4100	Fire Station 1 – Bldg 4100	Northwest of Intersection of West Way and Lewis Drive	AFFF storage in, and refilling of, ARFF vehicles, and delivery of bulk quantities of AFFF
Ft. Lewis - Fire Station 7 – Bldg 2014	Fire Station 7 – Bldg 2014	On Pendleton Avenue, between 3rd and 4th Streets	AFFF storage in, and refilling of, ARFFs, and delivery of bulk quantities of AFFF. Dry wells indicated as adjacent to building.

QAPP Worksheet #10 – Problem Definition (Continued)

Table 10-1 (continued)
Summary of Potential PFAS Source Areas

Area Name	Site Number/ Potential Area of Concern	General Location	Potential Concern
North Ft. Lewis - LF #5	LF #5	West side of North Fort Lewis	Potential leaching of PFAS compounds from landfill contents to groundwater, biosolids disposal, surface water drainage to the landfill and infiltration through landfill contents
North Ft. Lewis - Landfill #4	North Ft. Lewis - Landfill #4	North of Sequalitchew Lake	Potential leaching of PFAS compounds from landfill contents to groundwater
Ft Lewis Buildings 1206 / 1210 Ranges	Buildings 1206 / 1210 Ranges	West Ft Lewis (Forestry)	Storage of AFFF, and unknown area of use
North Ft Lewis – AOCs 15-1 and 15-2	AOC 15 (1957)	Along north side of South Drive	Historic use of AFFF for firefighting practice
North Ft Lewis – Wash Rack	Current wash rack	South Drive and A Street Adjacent to North Fort AOC 15-1 and 15-2	Surfactants use
North Ft. Lewis - Historic Solvent-Refined Coal Plant	Historic petroleum plant	Ft Lewis – South of Sequalitchew Lake, near Production Well 12B	Unknown compounds used in coal solvent refining process, could have included PFAS, proximal to Sequalitchew Spring well and Well 12 A/B
Ft. Lewis Logistics Center - Building 9612 Current wash rack	Current wash rack	Northeast of Rainier Drive	Surfactants use
Ft. Lewis Logistics Center - Building 9626 Historic wash rack	Historic wash rack	North of Rainier Drive and South L Street intersection	Historic surfactants use
Ft. Lewis Logistics Center - Building 9636 Bulk “Fuel Spot”			Potential release from AFFF system
Ft. Lewis Logistics Center: Historic waterproofing	Historic waterproofing in area of Buildings 9630/9640 and 9570/9580	Ft Lewis - Logistics Center, middle to northwest portion	Historic use of waterproofing
Ft. Lewis Logistics Center: Historic laundry	Laundry-Bldg 9060 at Log Center	Ft Lewis - Logistics Center	Historic use of and surfactants

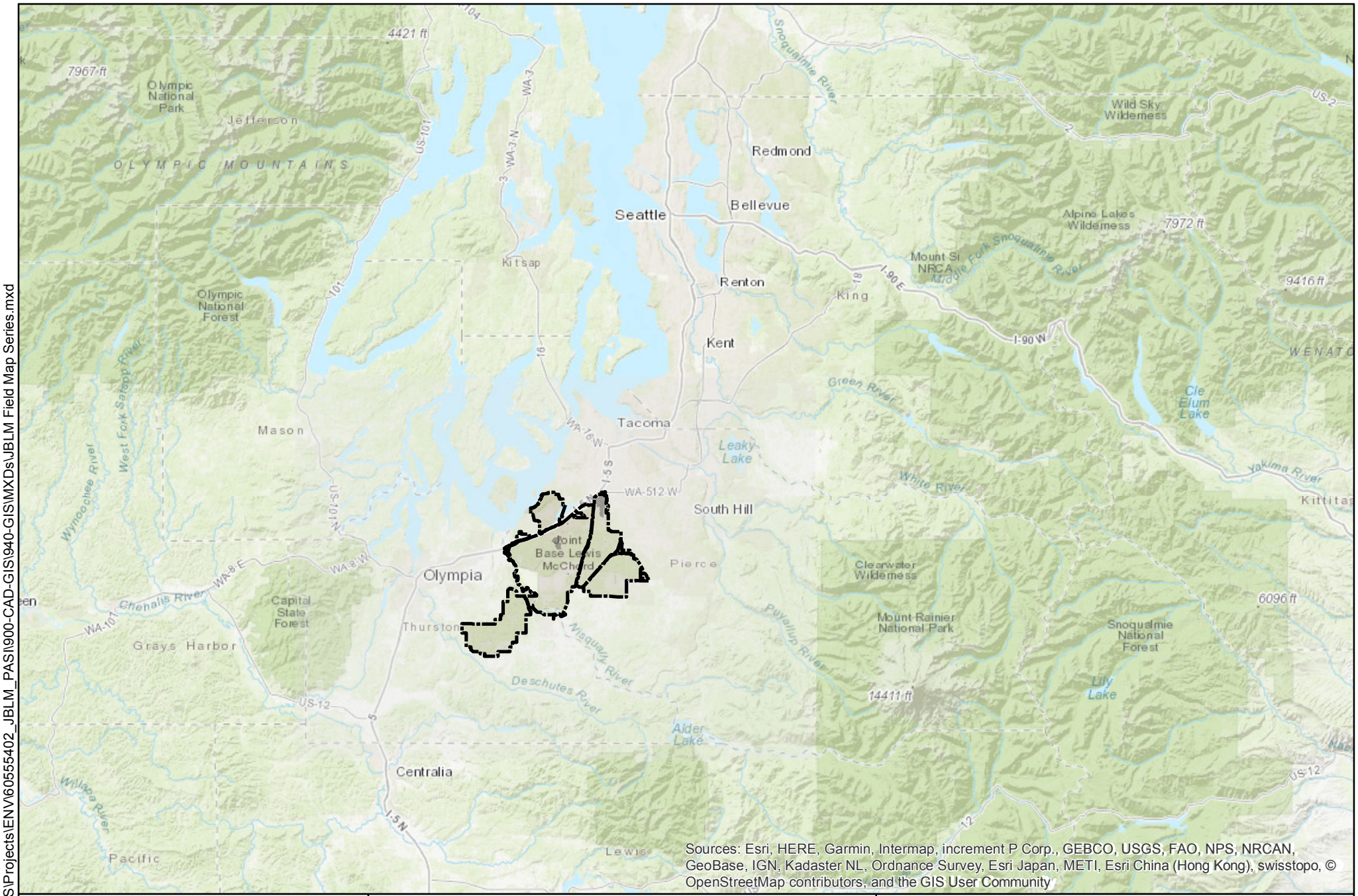


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Figure 10-1
Site Location Map
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

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QAPP Worksheet #10 – Problem Definition (Continued)

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Landfill No. 11(a)
Landfill No. 12
Park Marsh Landfill
Landfill #5
Landfill #4
Sequalitchew Spring
Well 12B
Well 12A
Landfill 004
Housing Well II
Housing Well I
Housing Well III
Landfill 002
Landfill 001
Landfill 016
Landfill 017
Landfill 019
Landfill 020
Landfill 011
North Well
South Well
Landfill 021
East Well
Landfill 012
Prime Beef Replacement Well I
Landfill 010
Landfill 022
Landfill 013
Landfill 005
OT039
Landfill 007
MARS Hill
Sage Well II
Sage Well I
Landfill 006
Replacement Well II
Landfill 025
Landfill 014
Landfill 024
Landfill 015
MAMC-04
Well 13
Landfill #2
Landfill 023
Well 10
Well 23
Landfill #7

Legend

JBLM Production Wells (ppt)
PFOS and PFOA
- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

10-Year WHPA/Capture Zones
JBLM Boundary

N

0 0.5 1 2 Miles

Figure 10-2
Production Well PFOS + PFOA Sampling Results
Northern Portion of JBLM
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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QAPP Worksheet #10 – Problem Definition (Continued)

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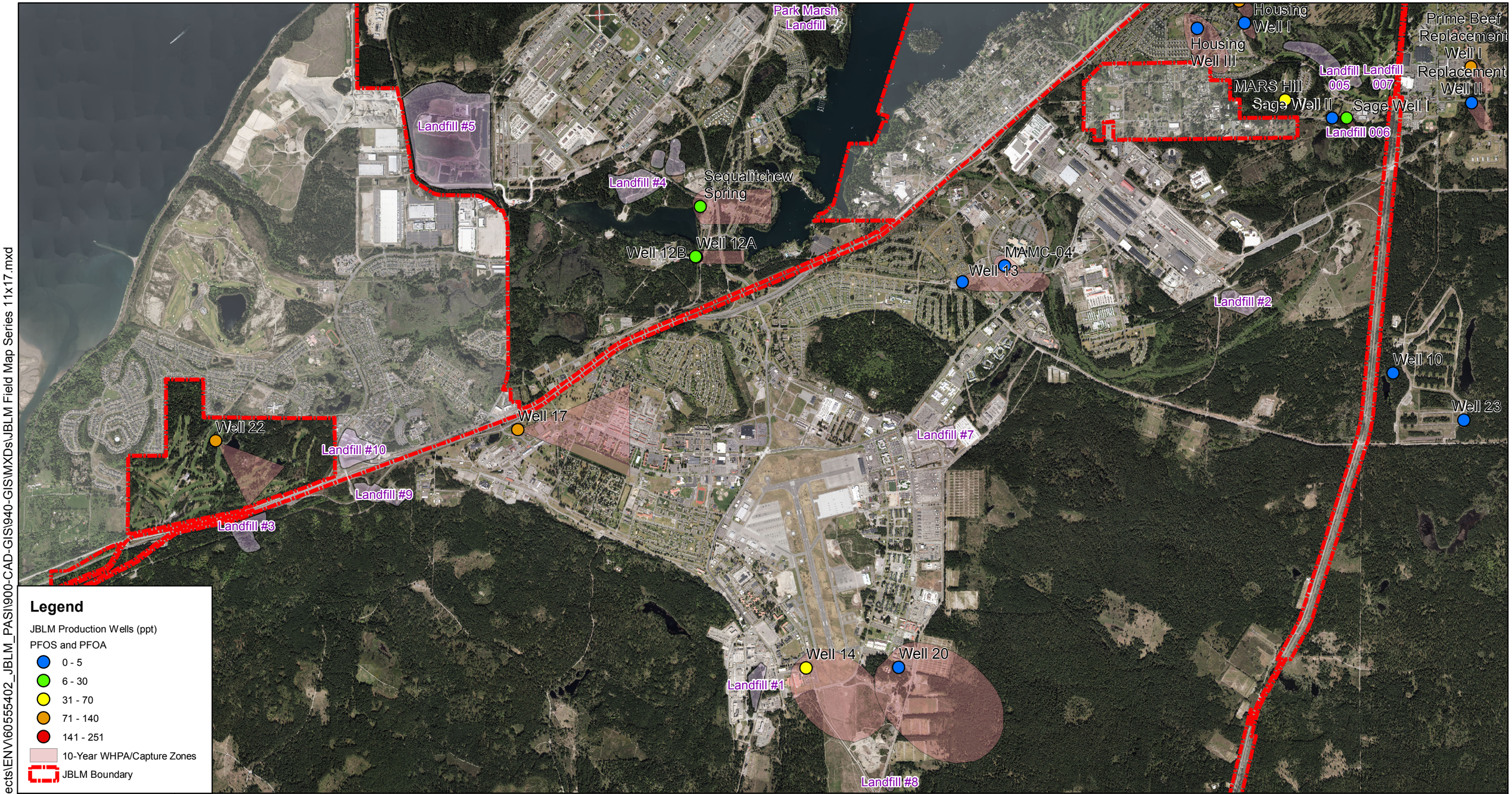

Figure 10-3
Production Well PFOS + PFOA Sampling Results
Southern Portion of JBLM
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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QAPP Worksheet #10 – Problem Definition (Continued)

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QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements

Data quality objectives are an integrated set of qualitative and quantitative decision statements that define data quality requirements based on the end use of the data. The EPA has developed a seven-step process to clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Step 1: State the problem. This step identifies the issues to be addressed.

Problem statement: "Six production wells have detected concentrations of PFOS/PFOA above the EPA LHA of 70 ppt."

Step 2: Identify the decision. This step is to define the decision that will be made using data to address the problem**.** The overall decisions to be made based on the data collected under this QAPP are as follows:

1) If the total concentration of PFOS, PFOA, and 4 other specific PFAS compounds in a groundwater sample is above 70 ppt, then the associated potential source area will require further evaluation. The six PFAS compounds are:
    - Perfluorooctanesulfonic Acid (PFOS)
    - Perfluorooctanic Acid (PFOA)
    - Perfluorobutanesulfonic Acid (PFBS)
    - Perfluoroheptanoic Acid (PFHpA)
    - Perfluorohexanesulfonic Acid (PFHxS)
    - Perfluorononanoic Acid (PFNA)
2) If the total PFAS concentrations of these six PFAS compounds in all groundwater samples for a potential source area are below 70 ppt, then the associated potential source area will not require further evaluation at this time.

Step 3: Identify the inputs to the decision. Inputs to the decision will consist of the following:

- Results of the Preliminary Assessment (PA)
- Prioritization of the source areas identified during the PA
    - AFFF application, spills, and storage
    - Waterproofing and surfactant operations
    - Landfills
- Site hydrogeology and existing capture zones/wellhead protection areas

QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements (Continued)

- Existing analytical data collected from the production wells
- Phase I analytical sampling results
- Phase II analytical sampling results
- Comparison of analytical results to the EPA HAL

Step 4: Define the site boundaries. The spatial boundaries of the site are shown on Figure 11-1. At this time, the site boundaries are the installation boundaries. Individual site boundaries within the installation may be refined over time.

Step 5: Develop a decision rule. The process or "rules" for making the decisions listed under Step 2 are described in this section. Rules include how field decisions will be made, as well as how data will be interpreted.

Groundwater/surface water samples will be collected from 45 locations during the Phase I event. Results of Phase I will be used by the Technical Project Team to guide the Phase II well installation and sampling location selection. The areas with the highest concentration of detections in Phase I samples will be prioritized in Phase II. Up to 15 new wells or 950 linear feet of total well construction and sampling from 20 locations will be conducted during Phase II.

Decision 1 - If the total PFAS concentration of six UCMR compounds in a groundwater sample is above 70 ppt, then the associated potential source area will require further evaluation.

1) Collect groundwater and surface water samples during Phase I and II and analyze for 14 PFAS compounds.
2) Compare the analytical results to the EPA HAL of 70 ppt to make Decision 1.
3) "U" qualified result (not detected above the specified practical quantitation limit [PQL] will be assigned one-half the value of the PQL.

Decision 2 - If the total PFAS concentrations of six UCMR-3 compounds in all groundwater samples for a potential source area are below 70 ppt, then the associated potential source area will not require further evaluation at this time.

1) Collect groundwater and surface samples during Phase I and II and analyze for 14 PFAS compounds.
2) Compare the analytical results to the EPA LHA of 70 ppt to make Decision 2.
3) "U" qualified result (not detected above the specified practical quantitation limit [PQL] will be assigned one-half the value of the PQL.

Step 6: Specify limits on decision errors. The investigation will use decision-error minimization techniques in sampling design, sampling methodologies, and laboratory

QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements (Continued)

measurements. Possible decision errors will be minimized during the field investigation by using the following methods:

Use standard field sampling methodologies (as discussed in Worksheets #14 and #21).

Use applicable analytical methods and SOPs for sample analysis by a competent analytical laboratory.

The selected laboratory may change over the course of the project. A laboratory with a current DoD ELAP certification must be used for groundwater samples as specified in Worksheet #8.

Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and duplicate samples as summarized in Worksheets #12, #18, #20, and #28.

Field screening of the groundwater parameters is a standard procedure in the development and sampling of wells. Field screening of the groundwater parameters shall be of sufficient quality to determine whether the aquifer has stabilized so that samples collected represent actual aquifer characteristics.

All sample information will be transcribed into a field logbook and/or onto field data sheets.

AECOM will provide data validation services and verify and evaluate the usability of the data as described in Worksheets #34 through #36.

Step 7: Optimize the sampling design.

The results of the Phase I sampling event will be used to optimize Phase II the well installation and sample locations selected for Phase II.

The specific locations and rationale for the Phase I samples are described in Worksheet #s 17 and 18. This QAPP will be amended with tables and figures to specify Phase II sampling locations. These locations will be identified in consultation with the Technical Project Team.

QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements (Continued)

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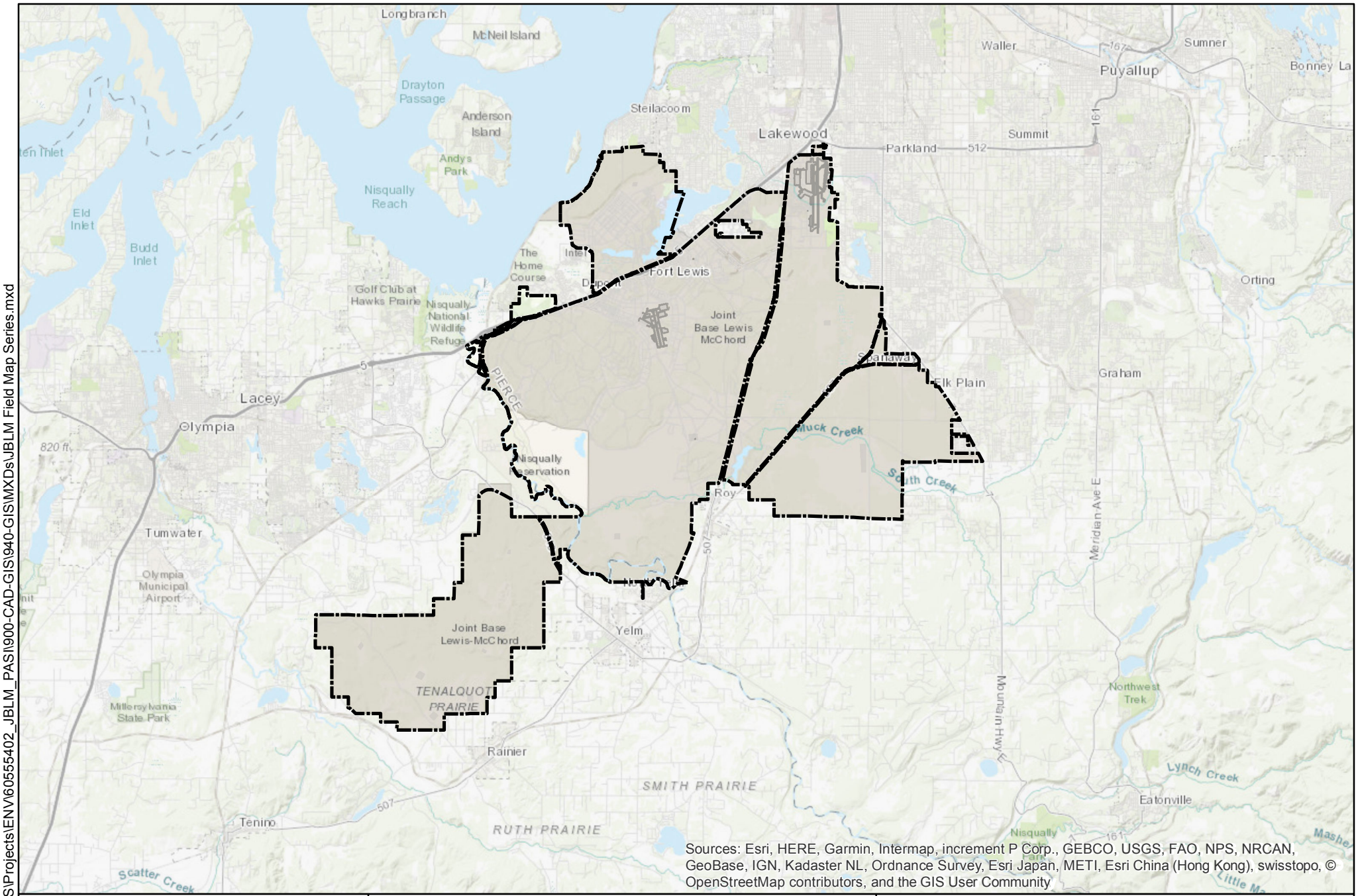

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0 3 6 12 Miles

Figure 11-1
Site Boundaries
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

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QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements (Continued)

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QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements (Continued)

Table 11-1
Groundwater Screening Levels and PRQLs

Chemical	Screening Level[a] (ppt)	PRQL[b] (ppt)
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	NE	7
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	NE	7
Perfluorobutanesulfonic acid (PFBS)	400,000[b]	20,000
Perfluorodecanoic acid (PFDA)	NE	7
Perfluorododecanoic acid (PFDoA)	NE	7
Perfluoroheptanoic acid (PFHpA)	NE	7
Perfluorohexanesulfonic acid (PFHxS)	NE	7
Perfluorohexanoic acid (PFHxA)	NE	7
Perfluorononanoic acid (PFNA)	NE	7
Perfluorooctanesulfonic acid (PFOS)	70[c]	7
Perfluorooctanoic acid (PFOA)	70[c]	7
Perfluorotetradecanoic acid (PFTA)	NE	7
Perfluorotridecanoic acid (PFTrDA)	NE	7
Perfluoroundecanoic acid (PFUnA)	NE	7

[a]Source: EPA's lifetime health advisories for PFOS and PFOA and tapwater RSL for PFBS (EPA 2016 a, b)
[b]Based on US EPA Regional Screening Levels (RSLs) (US EPA, 2017).
[c] Fact Sheet PFOA & PFOS Drinking Water Health Advisories. EPA 800-F-16-003, November 2016 (EPA 2016c). Guidance provides a health advisory level of 70 ppt for PFOS and PFOA. If both PFOS and PFOA are found to be present, the concentrations of both PFAS combined will be compared to the value of 70 ppt.

Notes:
EPA – [U.S.] Environmental Protection Agency
NE – not established
ppt – parts per trillion
PRQL – project-required quantitation limit
RSL – regional screening level

QAPP Worksheet #12 -- Field Quality Control Samples

Matrix	QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Groundwater/Surface Water	Field Duplicate	14 PFAS Compounds	1 per 10 samples	Precision	Relative Percent Difference (RPD) ±30%
Groundwater/Surface Water	Non-disposable Equipment Rinse	14 PFAS Compounds	1 per day	Accuracy, Bias	Evaluate possible bias for any detections of analytes listed Worksheet # 15. No analyte detected > ½ LOQ or >1/10 the amount measured in any sample or 1/10 of the regulatory limit, whichever is greater.
Groundwater/Surface Water	Matrix Spike / Matrix Spike Duplicate	14 PFAS Compounds	1 per 20 samples	Accuracy, Bias	See Worksheet #28 for matrix spike/matrix spike duplicate (MS/MSD) criteria.

QAPP Worksheet #13 -- Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
2017/2018 Production well data	JBLM Public Works	JBLM Public Works	Assist with source area evaluation and selection of Phase I and Phase II sampling locations.	No limitation has been established for these data.

QAPP Worksheet #14 -- Summary of Project Tasks

Phase I Groundwater and Surface Water Sampling

1. Collect groundwater samples from 38 monitoring wells identified in Worksheet #18 and shown on Figures 17-1 through 17-14.
2. Collect groundwater samples from treatment systems LF-2 P&T Influent, LF-2 P&T Effluent, I-5 P&T Influent, I-5 P&T Effluent, SLA P&T Influent and SLA P&T Effluent using the methods described in SOP A and E.
3. Collect a surface water sample from location SW-1 using methods described in SOPs A and E.

Phase II Installation of Supplemental Monitoring Wells

1. **Phase I results will be used to determine Phase II sampling locations. This QAPP will be amended with revised tables and figures following the receipt of Phase I results.**
2. Establish planned well installation locations (**QAPP amendment #1**) and mark proposed drilling locations with white marking paint.
3. Conduct utility locate.
4. Mobilize sonic drill rig to borehole location.
5. Advance each boring with sonic drill tooling to approximately the depths prescribed in revised Worksheet #s 17 and 18. WS #s 17 and 18 revisions will be based on Phase I sampling results.
6. Log soil lithology and field-screen soil samples for organic vapors using a photoionization detector (PID).
7. Construct up to 15 monitoring wells or 950 linear feet of total well construction as described in Worksheet #17 and QAPP amendment #1.
8. Complete surface [illegible] each monitoring well location as described in Worksheet #17.
9. Collect well locations, top-of-casing elevations, and ground surface elevations using the land surveying techniques described in SOP K.

Phase II Groundwater Sampling

1. Collect groundwater samples from well identified in Worksheet #18 using low-flow methods described in SOP B.

Analysis Tasks:

ALS Kelso will perform sample analysis. Groundwater will be analyzed for the 14 PFAS compounds identified in EPA Method 537 modified. Refer to Worksheet #23 for analytical method details.

Quality Control Tasks:

1. Implement SOPs for PFAS sampling, related field tasks, and sample preparation/analysis methods.
2. Field quality control samples are described in Worksheet #12. Laboratory analytical quality control samples are described in Worksheet #28.
3. Analytical laboratory data for the 14 PFAS compounds will be submitted for 100% independent data validation, which will be documented in a data validation report(s).

Secondary Data:

1. 2017/2018 production well sampling data collected by the JBLM Public Works Department will be used in evaluating source areas and in selecting Phase I and Phase II sampling locations.

Data Management Tasks:

1. Analytical data will be loaded into the JBLM electronic database following validation as directed by the JBLM PM.
2. Original hard copies of the analytical data packages and data validation reports will be submitted to the JBLM for archive.

QAPP Worksheet #14 -- Summary of Project Tasks (Continued)

2. Original hard-copy field data will be retained in the secure central project file, and photocopies will be used for data-reduction project work.

Documentation and Records:

1. Field data will be recorded in a bound logbook and on lithologic borehole log forms as described in SOP L.
2. Logbooks, chains-of-custody, airbills, and other hard-copy field records will be retained in the AECOM project file. Pertinent copies will also be appended to the report.

Data Packages:

Laboratory data will be recorded in a Contract Laboratory Program or similar format, including sample identification, analysis date, parameter values, method detection limits, and reporting limits. Laboratory data reports must include all information required to perform a comprehensive data validation. The data package elements required to perform data validation are listed below and will include both summary forms and instrumental printouts as applicable:

- Initial calibration
- Initial calibration verification
- Continuing calibration verification
- Blank spike results and control charts
- Results from initial calibration and continuing calibration blanks
- Method blank results
- Instrument tuning
- Internal standards results
- Surrogate recovery results
- Preparation logs
- Any other raw data necessary to fully document the analyses performed on the subject sample group

Assessment/Audit Tasks:

The laboratory selected to perform the analytical testing for this project will have current accreditation under the DoD Environmental Laboratory Accreditation Program (ELAP), which is based on the review of the laboratory's quality assurance manual, selected SOPs, SOP master list, list of major analytical instrumentation, performance test results, and an on-site assessment performed under DoD ELAP.

QAPP Worksheet #15 -- Reference Limits and Evaluation Table

PFOS and PFOA in Water

Analyte	Chemical Abstract Service ID	Project Action Limit (ppt)[a]	Project-Required Quantitation Limit (ppt)	Project Action Limit Reference	Project Quantitation Limit Goal	Laboratory Specific (ppt)		
						LOQ (PQL)	LOD	DL (MDL)
NEtFOSAA	2991-50-6	NE	7[d]	EPA's lifetime health advisories for PFOS and PFOA and tapwater RSL for PFBS	At least ½ the project action limit	5	2.4	0.69
NMeFOSAA	2355-31-9	NE	7			10	8	0.91
PFBS	375-73-5	400,000[b]	40,000			5	12	0.41
PFDA	335-76-2	NE	7[d]			5	12	0.46
PFDoA	307-55-1	NE	7[d]			5	12	0.53
PFHpA	375-85-9	NE	7[d]			5	12	0.31
PFHxS	355-46-4	NE	7[d]			5	12	0.35
PFHxA	307-24-4	NE	7[d]			5	24	0.89
PFNA	375-95-1	NE	7[d]			5	12	0.51
PFOS	1763-23-1	70[c]	7[d]			5	12	0.6
PFOA	335-67-1	70[c]	7[d]			5	0.8	0.27
PFTA	376-06-7	NE	7[d]			5	2	0.44
PFTrDA	72629-94-8	NE	7[d]			5	0.8	0.24
PFUnA	2058-94-8	NE	7[d]			5	12	0.6

[a]Fact Sheet PFOA & PFOS Drinking Water Health Advisories. EPA 800-F-16-003, November 2016 (US EPA 2016c).
Guidance provides a health advisory level of 70 ppt for PFOS and PFOA. If both PFOS and PFOA are found to be present, the concentrations of both PFAS combined will be compared to the value of 70 ppt.
[b]Based on US EPA Regional Screening Levels (RSLs) (US EPA, 2017).
[c]EPA Health Advisory Level
[d]One-tenth the PAL for PFOS and PFOA

Notes:
DL – Detection Limit as defined in DoD-QSM v5.1; equivalent to MDL
LOD – Limit of Detection as defined in DoD-QSM v5.1.
LOQ – Limit of Quantitation as defined in DoD-QSM v5.1; equivalent to PQL
MDL – method detection limit
PQL – project quantitation limit
RSL – regional screening level

QAPP Worksheet #16 – Project Schedule/Timeline Table

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Draft QAPP	AECOM	2/15/18	3/21/18	Draft QAPP	3/21/18
Internal Draft QAPP Review	JBLM	3/21/18	3/28/18	Draft QAPP	3/28/18
Draft QAPP review	AEC	4/2/18	5/2/18	DRAFT QAPP	
TPP #3 – QAPP comment resolution	AECOM, USACE, JBLM, EPA, Ecology, DOH	5/9/18	5/9/18		
Final QAPP	AECOM	5/9/18	5/30/18	Final QAPP	5/30/18
Field work –Phase I sampling	AECOM	6/20/18	7/1/18		
Laboratory analysis	ALS Kelso	7/1/18	7/31/18	Laboratory package	7/31/18
Data validation	AECOM	7/31/18	8/21/18	Validation package	8/21/18
TPP #4 – Review Phase I sampling results and selection of Phase II well and sampling locations	AECOM, USACE, JBLM, EPA, Ecology, DOH	8/8/18	8/8/18		
QAPP amendment based on TPP #4	AECOM	8/8/18	8/22/18	QAPP amendment	8/22/18
Field work – well installation and Phase II sampling	AECOM	9/9/18	10/9/18		
Laboratory analysis	ALS Kelso	10/9/18	11/8/18	Laboratory package	11/8/18
Data validation	AECOM	11/8/18	11/29/18	Validation package	11/29/18
TPP #5 – Field Investigation data review	AECOM, USACE, JBLM, EPA, Ecology, DOH	12/6/18	12/6/18		
Tentative Schedule Dates					
Draft Site Inspection (SI) report	AECOM	11/8/18	12/23/18	Draft SI report	12/23/18
Draft SI Report review	USACE, JBLM	12/23/18	1/22/19		
Draft SI report comment resolution	AECOM	1/22/19	2/5/19		
Draft Final SI report	AECOM	2/5/19	3/7/19	Draft Final SI Report	3/7/19
Draft Final SI report review	USACE, JBLM	3/7/19	4/6/19		
Final SI report	AECOM	4/6/19	5/6/19	Final report	5/6/19

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QAPP Worksheet #17 -- Sampling Design and Rationale

The intent of the investigation is to identify PFAS source areas on JBLM. Groundwater/surface water samples will be collected from 45 locations during the Phase I event (Figures 17-1 through 17-14). Results of Phase I will be used to guide the Phase II well installation and sampling location selection. The areas with the highest concentration of detections in Phase I samples will be prioritized in Phase II. Up to 15 new wells or 950 linear feet of total well construction and sampling from 20 existing locations will be conducted during Phase II.

This section describes the rationale and methodology for the specific sampling approach. Additional information is available in the SOPs provided in Appendix A and the Data Management Plan provided in Appendix B.

PFAS Sampling Considerations

There are hundreds of commercially available products that may contain residual PFAS and many are found in the sampling environment. These can be divided into two basic categories: 1) the sampling equipment and 2) the items within the sampling environment not related to the sampling equipment. The sampling equipment includes items such as bailers, pumps, tubing, sample jars and lids, gloves, sharpies, decontamination liquids and equipment, metal scoops, aluminum foil, coated field notebooks, etc. Items within the sampling environment not related to the sampling equipment include, but are not limited to, stain- and water-resistant fabrics found in outerwear and boots and in treated vehicle upholstery, personal care items, sunscreens and insect repellants, food wrappers/containers, residual fabric softeners on washed clothing, etc. What complicates evaluation of the PFAS contamination potential of items in this second category is the fact that manufacturers of these items have modified the suite of PFAS used and the amounts used in the manufacturing. In many cases, whether a specific item will be a source of PFAS contamination or not is hard to determine. As a precautionary measure, practical elimination of all of these items from the sampling environment is recommended.

Eliminating all items in the sampling environment that may be a potential source of PFAS contamination is particularly important as the various screening criteria and laboratory reporting limits for PFAS compounds are decreasing. For example, the EPA LHA for two commonly found PFAS compounds, PFOA and PFOS, separately or combined, is 70 ppt. The procedures prescribed in SOP A (Appendix A) shall be applied to each of the field activities described below.

Sampling Locations

The planned sampling locations were selected based on discussions with the project stakeholders during TPP #2, as described in Worksheet #9. A summary of the planned sampling locations and rationale is provided in Table 17-1.

Groundwater Sampling

Groundwater samples will be collected during the Phase I and Phase II events using low-flow techniques in accordance with SOP B (Appendix A). Water quality instruments will be calibrated in accordance with SOP C (Appendix A). Field measurements, including pH, specific conductance, turbidity, dissolved oxygen (DO), temperature, salinity and oxidation reduction potential (ORP), will be recorded during sampling in accordance with SOP D (Appendix A). Groundwater samples collected at each location will be field screened using a shaker test. A small volume (~10-25 milliliters [mL]) of groundwater will be collected and shaken by the sample collector on-site. If foaming is noted within the sample, it will be documented in the field logbook and on the laboratory chain of custody (CoC) when samples are submitted for analysis. This will alert the laboratory to the possible presence of elevated concentrations. Investigation-derived waste (IDW) will be contained in labeled Department of Transportation (DOT)-approved containers and managed as described below.

Surface Water Sampling

Surface water sampling will be conducted in accordance with SOP E (Appendix A). Samples will be collected using a disposable plastic device that is submerged, but only to a depth that prevents sediment disturbance. If the water level is too low at the time of sampling, a glass pipette will be used to collect the sample. The disposable plastic device or glass pipette will be used to fill the laboratory bottleware. Field parameters, including pH, temperature, DO, ORP/Redox, turbidity, and specific conductance will then be collected directly from the surface water sampling location. Surface water samples collected at each location will be field screened using a shaker test. A small volume (~10-25 mL) of surface water will be collected and shaken by the sample collector on-site. If foaming is noted within the sample, it will be documented in the field logbook and on the laboratory CoC when samples are submitted for analysis. This will alert the laboratory to the possible presence of elevated concentrations. IDW will be contained in labeled DOT-approved containers and managed as described below.

Field Rinsate Blanks

A field rinsate blank will be collected and analyzed only if nondisposable equipment is used. Field rinsate blanks will consist of PFAS-free water that has passed over and/or through decontaminated sampling equipment. Surfaces and materials exposed during actual sampling will be rinsed to evaluate the effectiveness of sampling equipment decontamination procedures and the potential for equipment or field cross contamination. Rinsate blanks will be collected at a rate of one per day per medium when non-disposable equipment is used and analyzed for the 14 PFAS compounds. Field equipment that is rinsed during the collection of the blank will be documented in the field logbook.

Blind Field Duplicates

To the extent possible, locations for blind field duplicate samples will be chosen where the expectation is that contamination is greater than the reporting limit. The field duplicates will consist of groundwater and surface water samples at a rate of 1 per 10 samples per medium. Sample names will be coded such that the laboratory cannot identify which samples are duplicates on the basis of the information on the sample label. The samples will be analyzed for the same parameters as the primary sample. Field duplicates will be noted on the sample collection form or in the field logbook.

Sample Analyses

Worksheet #11 identifies six PFAS compounds that will be used to make decisions. However, Ecology and or DOH may issue cleanup standards that include a different combination of PFAS compounds. As a result, samples collected will be analyzed for all 14 EPA Method 537-Modified compounds.

Sample Naming

Sample containers will be labeled before the samples are collected. Care will be taken to ensure that the sample container labels correspond with the specified sample location identification numbers.

Monitoring Well Samples

Monitoring well samples collected during the Phase I and Phase II sampling events will be named as follows:

- Monitoring Well Name – Date (yymmdd). For example, monitoring well LT-4 sampled on May 30, 2018, would be labeled LT-4-180530.

Monitoring well duplicate samples collected during the Phase I and Phase II sampling events will be labeled consecutively, as follows:

- GWDUP# - Date (yymmdd). For example, the first monitoring well duplicate sample collected on May 30, 2018, would be labeled GWDUP-1-180530.

Surface Water Samples

Surface water samples collected during the Phase I and Phase II sampling events will be named as follows:

- Surface Water Sampling Location Name – Date (yymmdd). For example, surface water sampling location SW-1 sampled on May 30, 2018, would be labeled SW-1-180530.

Surface water duplicate samples collected during the Phase I and Phase II sampling events will be labeled consecutively, as follows:

- SWDUP# - Date (yymmdd). For example, the first surface water duplicate sample collected on May 30, 2018, would be labeled SWDUP1-180530.

Field Rinsate Blanks

Field rinsate blank samples collected during the Phase I and Phase II sampling events will be labeled consecutively, as follows:

- FRB# - Date (yymmdd). For example, the first field rinsate blank collected on May 30, 2018, would be labeled FRB1-180530.

Dig Permitting and Pre-Intrusive Work Preparation

Any JBLM-required permits for subsurface work will be obtained during the pre-intrusive work preparation period. AECOM will coordinate with the JBLM Technical Representative to procure and complete all JBLM-required permitting for well installation.

A pre-construction meeting will be held on-site prior to the initiation of intrusive field work planned for Phase II. This meeting will address safety, schedule, and field reporting during the field work. The driller will obtain "start cards" for drilling all borings and wells and will properly register each well with Ecology. Wells will be constructed by a licensed well driller in accordance with Ecology's Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 Washington Administrative Code).

Utility Location

All utilities will be located in accordance with SOP F (Appendix A) prior to any subsurface penetration. AECOM will consult with JBLM and other appropriate representatives to identify potential utility locations at the site. AECOM will contact the One Call utility location center to have utilities marked. A private utility locator will be mobilized to locate any conductible buried utilities at each drilling location prior to surface penetration. The private utility locator will use toning, electromagnetic, or other equivalent equipment to conduct the utility locate. An AECOM representative will be present during the utility locate and will document the results. No surface penetration is allowed within 5 feet of a marked or otherwise identified utility.

Drilling and Monitoring Well Installation

All drilling and well installation activities proposed for Phase II will be conducted by a State of Washington-licensed well drilling contractor using rotosonic drilling methods. The rotosonic drilling method, also known as vibratory drilling or sonic drilling, uses an eccentrically oscillating drill head to produce high-frequency vibratory energy that is then transmitted down a drill string to a core barrel to quickly advance through the subsurface. Other than the soil or rock that is retrieved from inside the core barrel as a sample, drill cuttings are limited and are forced into the walls of the borehole. A drilling fluid such as water or air is usually not required with this drilling method. However, water may be used to cool the drill bit, if necessary, or to control heave.

Continuous soil cores will be collected during drilling and immediately logged upon retrieval. A tubular plastic sleeve with a sealed bottom will be placed beneath the core barrel. The core barrel will then be vibrated, causing the soil sample to be extruded into the plastic sleeve. Each plastic sleeve will be filled with no more than 3 feet of soil core. The plastic sleeve will then be marked with the sample interval using indelible ink. Cores will be approximately 6 inches in diameter, based on installation of 2-inch-diameter groundwater monitoring wells at some drilling locations (no 4-inch-diameter or larger wells are planned).

Recovered soil will be visually examined for evidence of contamination and classified in accordance with the Unified Soil Classification System. Soil will be field screened with a PID by inserting the PID probe into the plastic sleeve containing the soil core, assessing organic vapors along the length of the core, and documenting the results in the field logbook. General headspace analysis procedures are described in SOP G (Appendix A). The PID will be calibrated in accordance with manufacturer's instructions at the beginning and end of each day. Soil samples will not be collected for analytical analysis.

IDW soil cuttings and core-barrel samples will be contained in labeled DOT-approved containers and managed as described below.

Groundwater monitoring wells will be installed in accordance with SOP H (Appendix A). The exact number of wells to be installed will be selected based on the interpretation of the data collected during Phase I and with the concurrence of the Technical Project Team. Well screen intervals will be determined based on the Phase I groundwater results and observed field conditions during Phase II, in consultation with the USACE and JBLM.

The wells will be constructed of flush-threaded Schedule 40 polyvinyl chloride (PVC) and will have a sand trap on the bottom, an estimated 10 feet of 0.010 slot screened well casing, and blank well casing to ground surface and sealed with a lockable compression cap. The filter pack around the screen will consist of 2/12 Monterrey sand, and the well seal will consist of hydrated bentonite chips.

Wells will be completed with above-ground steel "stick-up" protective casings surrounded by three bollards in unpaved portions of the site, and with traffic-rated flush mount monuments in paved portions of the site.

Boring logs and well construction diagrams will be completed that include the driller's license number and are signed by the licensed driller. The driller will upload these logs to Ecology's database, as required. The Washington State Well ID for each installed well will be provided by the well drilling contractor.

Well Development

Well development will be conducted at newly installed wells to establish a hydraulic connection between the well and the surrounding saturated formation, settle the filter pack, and remove accumulated sediment that may enter the well during installation. Standard methods for monitoring well development are described in SOP I (Appendix A). Water quality instruments will be calibrated in accordance with SOP C (Appendix A). Well development will be performed a minimum of 48 hours after well construction to allow time for the bentonite or grout

seal to cure. Development will be performed by first using a surge block followed by a bailer (PVC or stainless steel) to remove sediments from the well and surrounding filter pack. Multiple iterations of surging and bailing will be required, dependent on the aquifer characteristics.

Once the bailed water is visually free of sediments, development will continue using high-flow pumping techniques (greater than 0.5 liter per minute) until the water quality parameters (temperature, pH, specific conductance, and turbidity) stabilize to within 10 percent of the previous reading for three consecutive measurements, or until five borehole volumes (well casing plus annular space) have been removed. Because the monitoring wells may be screened in silty material, water quality parameters, notably turbidity, may not stabilize using high-flow pumping techniques. If water quality parameters do not stabilize to within 10 percent after five well volumes, low-flow pumping techniques (less than 0.5 liter per minute) will be performed for an additional well volume to better document groundwater conditions encountered during low-flow groundwater sampling. Well development water will be contained in labeled DOT-approved containers and managed as described below.

The following information will be recorded during the development of each well:

- Date, time, personnel, and well designation
- Static groundwater levels
- Volume of water in well prior to development
- Volume of water removed
- Observations of water characteristics (e.g., color, odor, turbidity)
- Description of development technique

IDW Handling and Management

Drill cuttings and purge/decontamination water will be placed in DOT-approved 55-gallon drums filled approximately two-thirds full. The drums will be transported to a storage location identified by JBLM. Stored IDW will be sampled for characterization. Characterization results will be provided to JBLM for use in determining final disposition. Final IDW disposition is JBLM's responsibility. Standard methods for IDW handling and management are described in SOP J (Appendix A).

Monitoring Well Surveying

All monitoring wells installed under this QAPP will be surveyed by a State of Washington-licensed surveyor. After the monitoring wells are installed, a notch or mark will be made at the top of the inner casing. The vertical location of these points will be surveyed to a reference point determined in the field and reported to within 0.01 foot. All elevations will be referenced to the North American Vertical Datum (NAVD) 1988. The horizontal locations of each point will be documented in North American Datum (1983/91) Washington State Plane North Zone with an accuracy of up to 0.1 foot. The top-of-casing and ground surface elevations and casing locations will be surveyed. Standard methods for surveying are described in SOP K (Appendix A).

Table 17- 1
Planned Sampling Locations Rationale

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
LT-4	Groundwater	16.3 - 26.3	Assess for the presence of PFAS in shallow groundwater along JBLM boundary	North McChord Hangars and Runways	North Well	17-1
CW-62	Groundwater	30-40	Assess for the presence of PFAS in shallow groundwater adjacent to a losing reach of Clover Creek	Clover Creek	North Well	17-3
IW-2	Groundwater	35 - 45	Assess for the presence of PFAS in shallow groundwater and distribution following sodium permanganate oxidation	Clover Creek and McChord Hangars	North Well	17-2, 17-3
CW-64	Groundwater	45 - 60	Assess for the presence of PFAS in shallow groundwater	Clover Creek and McChord Hangars	North Well	17-2, 17-3
1168-MW01	Groundwater	7 - 22	Assess for the presence of PFAS in shallow groundwater along JBLM boundary	North McChord Hangars and Runways	North Well	17-1
CR-01	Groundwater	8 - 38	Assess for the presence of PFAS in shallow groundwater	McChord Hangars, Runways and Clover Creek	North Well	17-2
CW-29B	Groundwater	18 - 23	Assess for the presence of PFAS in shallow groundwater	McChord Hangars, Runways and Clover Creek	North Well	17-2

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
CW-4	Groundwater	16.9 - 26.9	Assess for the presence of PFAS in shallow groundwater along JBLM boundary	McChord Hangars, Runways and Clover Creek	North Well	17-3
Surface Water 1	Surface water	n/a	Assess for the presence of PFAS in surface water within Clover Creek down gradient of McChord Hangar/Runway surface water discharge	McChord Hangars, Runways and Clover Creek	North Well	17-2
FTA-4a	Groundwater	16 - 26	Assess for the presence of PFAS in shallow groundwater downgradient of FT032	FT032	East Well	17-6
FTA-4b	Groundwater	68 - 78	Assess for the presence of PFAS in intermediate groundwater downgradient of FT032	FT032	East Well	17-6
IH-1a	Groundwater	32.8 - 37.8	Background sample to assess for the presence of PFAS in shallow groundwater upgradient of potential areas of concern, adjacent to the JBLM boundary	Landfill 013	East Well	17-6
IH-1b	Groundwater	51.8 - 56.8	Background sample to assess for the presence of PFAS in	Landfill 013	East Well	17-6

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
			intermediate groundwater upgradient of potential areas of concern, adjacent to the JBLM boundary			
IH-3b	Groundwater	52.8 - 57.8	Assess for the presence of PFAS in intermediate groundwater downgradient of Landfill 013	Landfill 013	East Well	17-6
LT-9	Groundwater	130 - 140	Assess for the presence of PFAS in deep groundwater downgradient of FT032 and Landfill 013, within the capture zone/wellhead protection area of East Well	FT032 and Landfill 013	East Well	17-6
CW-15d	Groundwater	255.4 - 265.4	Assess for the presence of PFAS in deep groundwater immediately adjacent to North Well, within discrete intervals that correspond with North Well perforated zones	McChord Hangars, Runways and Clover Creek	North Well	17-4
CW-15c	Groundwater	98.6 - 108.6	Assess for the presence of PFAS in deep groundwater immediately adjacent to North Well, within discrete intervals that	McChord Hangars, Runways and Clover Creek	North Well	17-4

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
			correspond with North Well perforated zones			
MF-1	Groundwater	4.5 - 19.5	Assess for the presence of PFAS in shallow groundwater adjacent to Clover Creek	McChord Hangars, Runways and Clover Creek	North Well	17-2
CW-14a	Groundwater	25 - 35	Assess for the presence of PFAS in shallow groundwater immediately adjacent to South Well	McChord Hangars, Runways and Clover Creek	South Well	17-4
CW-14c	Groundwater	159.5 - 169.5	Assess for the presence of PFAS in deep groundwater immediately adjacent to South Well, within discrete intervals that correspond with North Well perforated zones	McChord Hangars, Runways and Clover Creek	South Well	17-4
CW-14d	Groundwater	265 - 275	Assess for the presence of PFAS in deep groundwater immediately adjacent to South Well, within discrete intervals that correspond with North Well perforated zones	McChord Hangars, Runways and Clover Creek	South Well	17-4
DA-7e	Groundwater	115 - 125	Assess for the presence of PFAS in deep groundwater	Landfill 005	MARS Hill	17-8

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
			downgradient of Landfill 005			
DA-21a	Groundwater	27.6 - 32.6	Assess for the presence of PFAS in shallow groundwater downgradient of Landfill 005	Landfill 005	MARS Hill	17-8
DO-2	Groundwater	40 - 70	Assess for the presence of PFAS in intermediate groundwater downgradient of Landfill 005	Landfill 005	Housing Well I	17-8
DO-5b	Groundwater	13 - 18	Assess for the presence of PFAS in shallow groundwater adjacent to ALGT treatment system recharge trenches	Landfill 005	Housing Well I	17-8
DA-4a	Groundwater	36.6 – 41.6	Assess for the presence of PFAS in shallow groundwater in the vicinity of a new proposed production well	Landfill 005/006	Sage Well I	17-14
DA-4b	Groundwater	60.9 – 65.9	Assess for the presence of PFAS in shallow groundwater in the vicinity of a new proposed production well	Landfill 005/006	Sage Well I	17-14
LC-23	Groundwater	20 - 45	Assess for the presence of PFAS in shallow groundwater within Landfill #2	Landfill #2	MAMC-04/Sage Well II	17-9

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
LC-230	Groundwater	24-44	Assess for the presence of PFAS in shallow groundwater downgradient of Landfill #2	Landfill #2	MAMC-04/Sage Well II	17-9
LF-2 P&T Influent	Groundwater	n/a	Assess for the presence of PFAS in influent groundwater intercepted by treatment system	Landfill #2	MAMC-04	17-9
LF-2 P&T Effluent	Groundwater	n/a	Assess for the presence of PFAS in effluent groundwater intercepted by treatment system	Landfill #2	MAMC-04	17-9
I-5 P&T Influent	Groundwater	n/a	Assess for the presence of PFAS in influent groundwater intercepted by treatment system	Landfill #2	MAMC-04	17-11
I-5 P&T Effluent	Groundwater	n/a	Assess for the presence of PFAS in effluent groundwater intercepted by treatment system	Landfill #2	MAMC-04	17-11
SLA P&T Influent	Groundwater	n/a	Assess for the presence of PFAS in influent groundwater intercepted by treatment system	Landfill #2	MAMC-04	17-11
SLA P&T	Groundwater	n/a	Assess for the presence of	Landfill #2	MAMC-04	17-11

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
Effluent			PFAS in effluent groundwater intercepted by treatment system			
84-CD-LF1-1	Groundwater	20 - 60	Assess for the presence of PFAS in shallow groundwater upgradient of Landfill #1, in the vicinity of Well 14.	Landfill #1/Gray Field Hangars/SWMU 47	Well 14	17-10
84-CD-LF1-4	Groundwater	20 - 60	Assess for the presence of PFAS in shallow groundwater downgradient of Landfill #1, in the vicinity of Well 14.	Landfill #1/Gray Field Hangars/SWMU 47	Well 14	17-10
LF4-PNL1	Groundwater	22 - 37	Assess for the presence of PFAS in shallow groundwater adjacent to Landfill #4, in the vicinity of Sequalitchew Springs and Well 12B.	Landfill #4	Sequalitchew Springs/Well 12B	17-13
LF4-01	Groundwater	22 - 28	Assess for the presence of PFAS in shallow groundwater adjacent to Landfill #4, in the vicinity of Sequalitchew Springs and Well 12B.	Landfill #4	Sequalitchew Springs/Well 12B	17-13
LF4-MW-10	Groundwater	22 - 37	Assess for the presence of PFAS in	Landfill #4	Sequalitchew Springs/Well 12B	17-13

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
			shallow groundwater adjacent to Landfill #4, in the vicinity of Sequalitchew Springs and Well 12B.			
4131-MW04	Groundwater	23 - 33	Assess for the presence of PFAS in shallow groundwater upgradient of and within the capture zone/wellhead protection area of Well 17.	Historic waterproofing, laundry	Well 17	17-12
01035-MW01	Groundwater	15 - 30	Assess for the presence of PFAS in shallow groundwater upgradient of Well 17.	Historic waterproofing, laundry	Well 17	17-12
CW-12	Groundwater	11 - 21	Background sample to assess for the presence of PFAS in shallow groundwater upgradient of potential areas of concern, adjacent to the JBLM boundary	FT029	East Well	17-5
CW-33c	Groundwater	70 - 80	Assess for the presence of PFAS in intermediate groundwater adjacent to and within the capture zone/wellhead protection area of Prime Beef	Landfill 013/FT032	Prime Beef Replacement Well I	17-7

Table 17-1
Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Production Well	Figure Reference
			Replacement Well I			
98-IA-MW-08	Groundwater	38 - 43	Assess for the presence of PFAS in shallow groundwater upgradient of Well 14 and SWMU47, and within the capture zone/wellhead protection area of Well 20.	SMWU 47	Well 20	17-10

1

Table 17-1
Planned Sampling Locations Rationale (continued)

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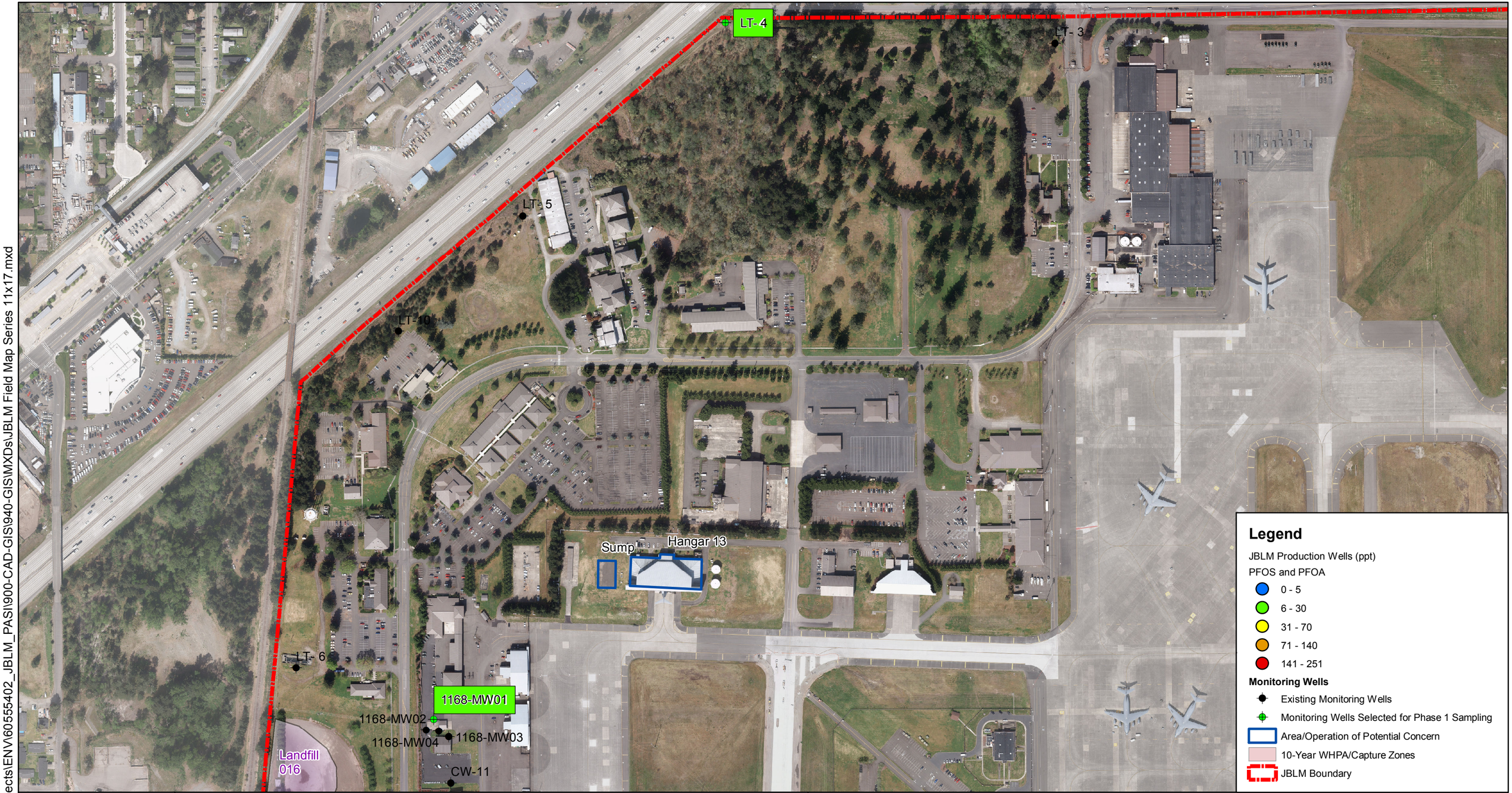

N

0 0.075 0.15 0.3 Miles

Figure 17-1

Phase 1 Sampling Locations

North McChord Runway and Hangar Source Area

PFAS Site Inspection

Joint Base Lewis McChord

Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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CW-65a
CW-65
CW-66
CW-64
CW-38
CW-26
CW-39
CW-25
CW-40
CW-37
CW-63
Landfill 017
IW- 2
CW-41
CW-44
CW-50
CW-43
CW-52
CW-51
SW-1
5
CR-01
CR-02
Historic
Wash Rack
CW-29b
CW-20
Taxiway D
CW-31b
CW-31a
CW-31c
MF-4
MF-3
MF-1
MF-2

Legend

JBLM Production Wells (ppt)
PFOS and PFOA
- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells
- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Surface Water Sample Locations
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.05 0.1 0.2 Miles

Figure 17-2
Phase 1 Sampling Locations
McChord Hangars/Clover Creek Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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Figure 17-3
Phase 1 Sampling Locations
McChord Hangars Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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Tank Farm

CW-15d
CW-15c
CW-15
North Well

CW-22
CW-21
CW-23
CW- 9
CW- 1

South Well
CW-24
CW-14b
CW-14a
CW-14d
CW-14c

1
2

Legend

JBLM Production Wells (ppt)
PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.05 0.1 0.2 Miles

Figure 17-4
Phase 1 Sampling Locations
McChord Hangars/FTA-033 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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Landfill 011

FT028

CW-12

FT029

FT030

Landfill 021

Legend

JBLM Production Wells (ppt)

PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.075 0.15 0.3 Miles

Figure 17-5
Phase 1 Sampling Locations
FTA-029 Source Area
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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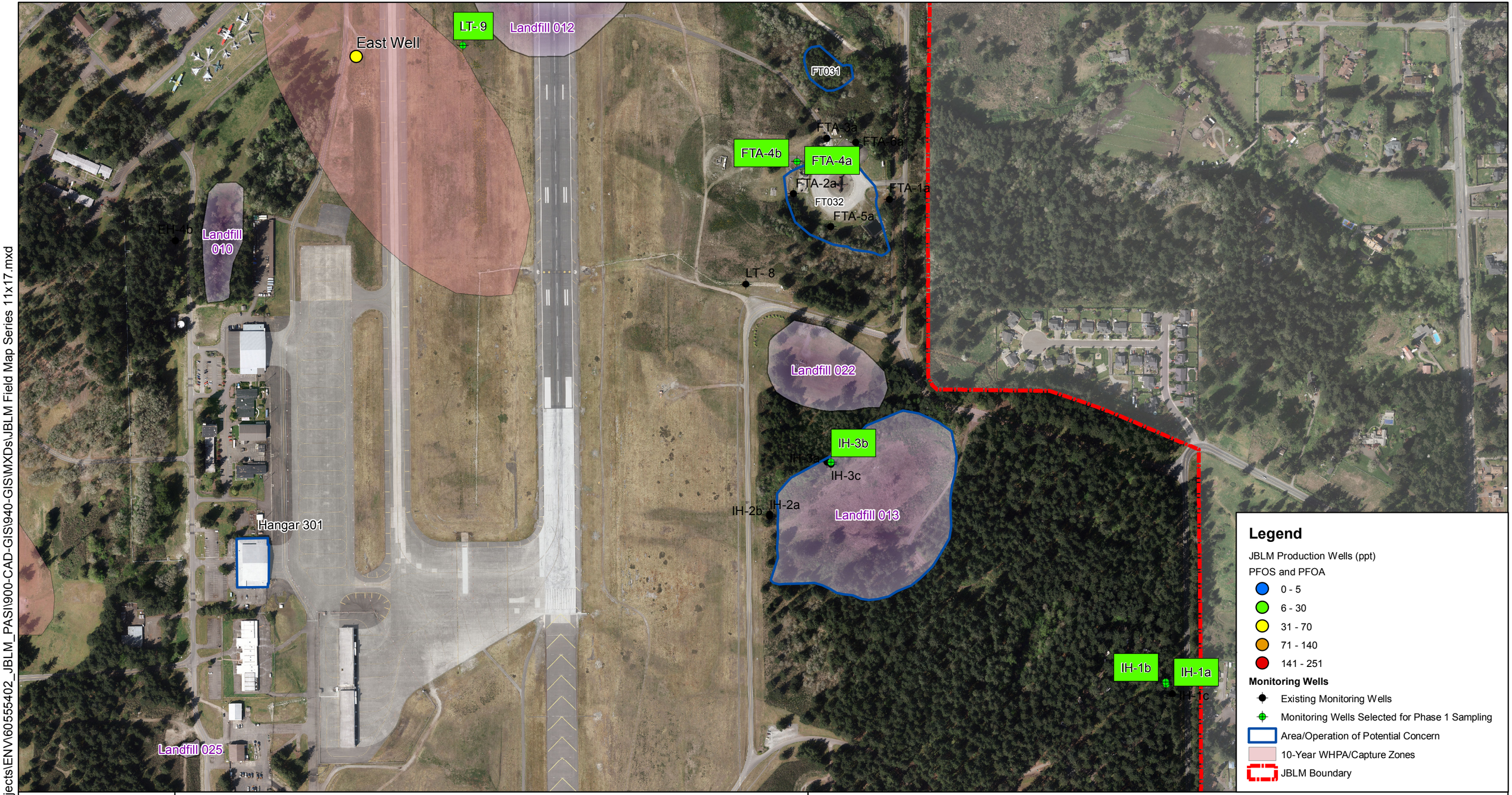

N

0 0.1 0.2 0.4 Miles

Figure 17-6
Phase 1 Sampling Locations
FTA-032 and Landfill 013 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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N

0 0.075 0.15 0.3 Miles

Figure 17-7
Phase 1 Sampling Locations
South McChord Field Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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Housing Well II
Housing Well I
DA-13a
DO-5a
DO-5b
DA-28
DR-05
DO-2
DX-2
DT-2
DA-11b
DA-11a
DA- 9a
DA- 9b
DB- 6
DX-3
DO-3
DA-29
DA-21b
DA-21a
DA-12c
DA-12e
DA-12d
DA-30a
DA-30b
DO-1a
DT-1
DA-25b
DX-1
DZ-13
DA- 7e
DA- 7b
DA-32
DA- 6a
Landfill 005
DA-31
Landfill 007
OT039
DB-11
DA- 2d
DA- 2c
DA- 2a
DA- 2b
MARS Hill

Legend

JBLM Production Wells (ppt)

PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.1 0.2 0.4 Miles

Figure 17-8
Phase 1 Sampling Locations
Landfill 005
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

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Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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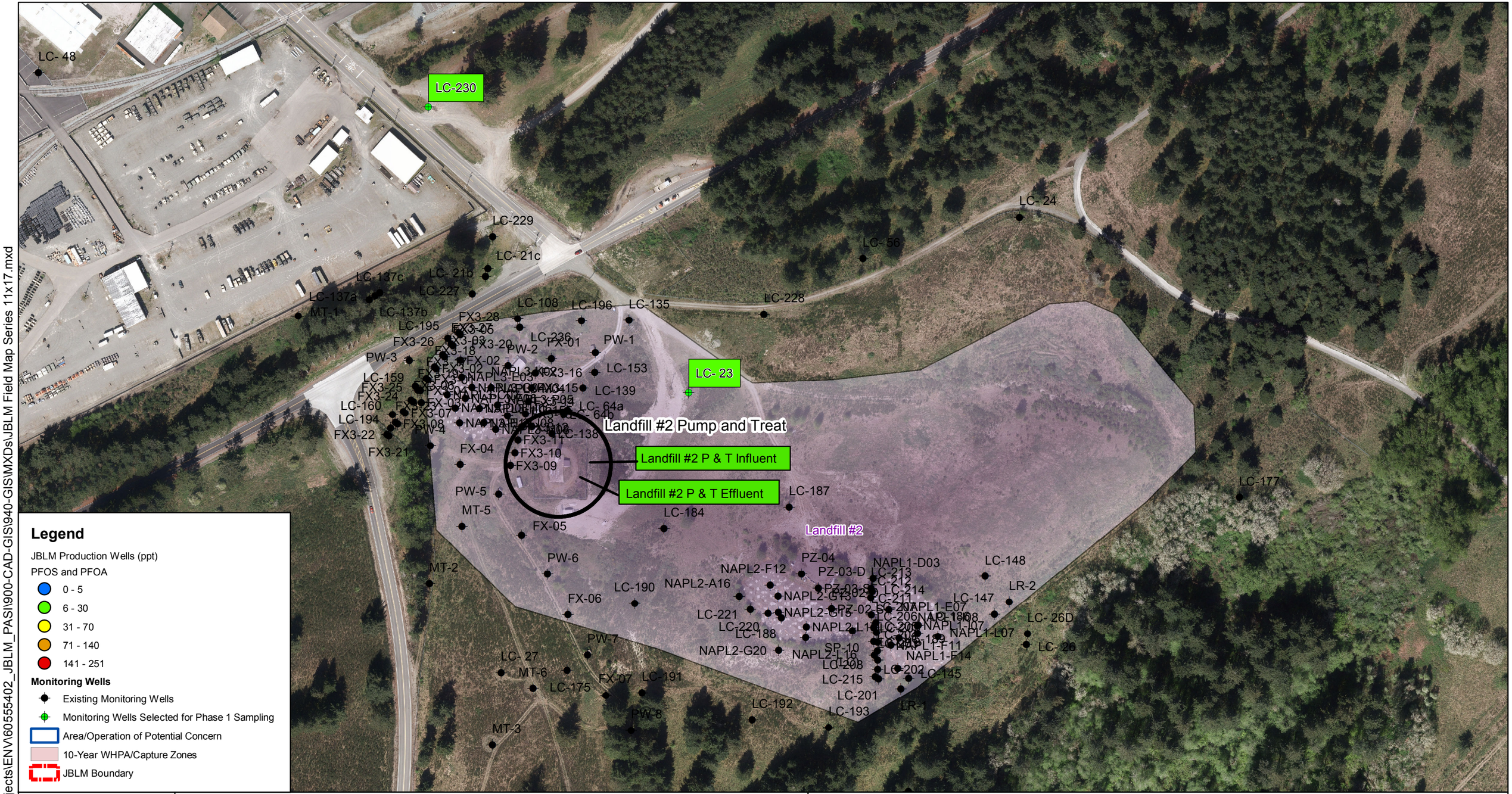

Legend

JBLM Production Wells (ppt)

PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.05 0.1 0.2 Miles

Figure 17-9
Phase 1 Sampling Locations
Landfill #2
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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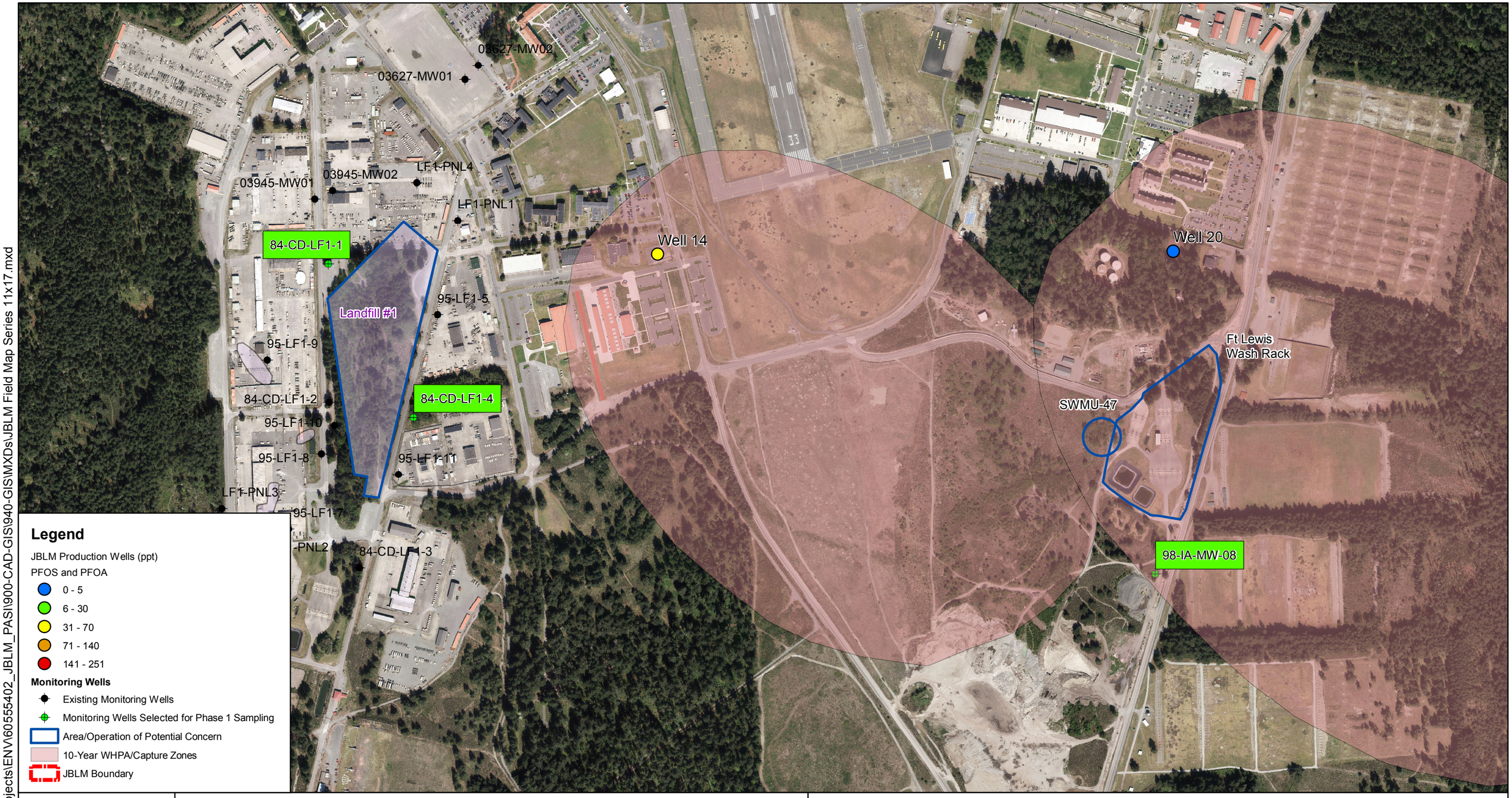

Figure 17-10
Phase 1 Sampling Locations
Landfill #1, Gray Field Hangar, SWMU 47
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

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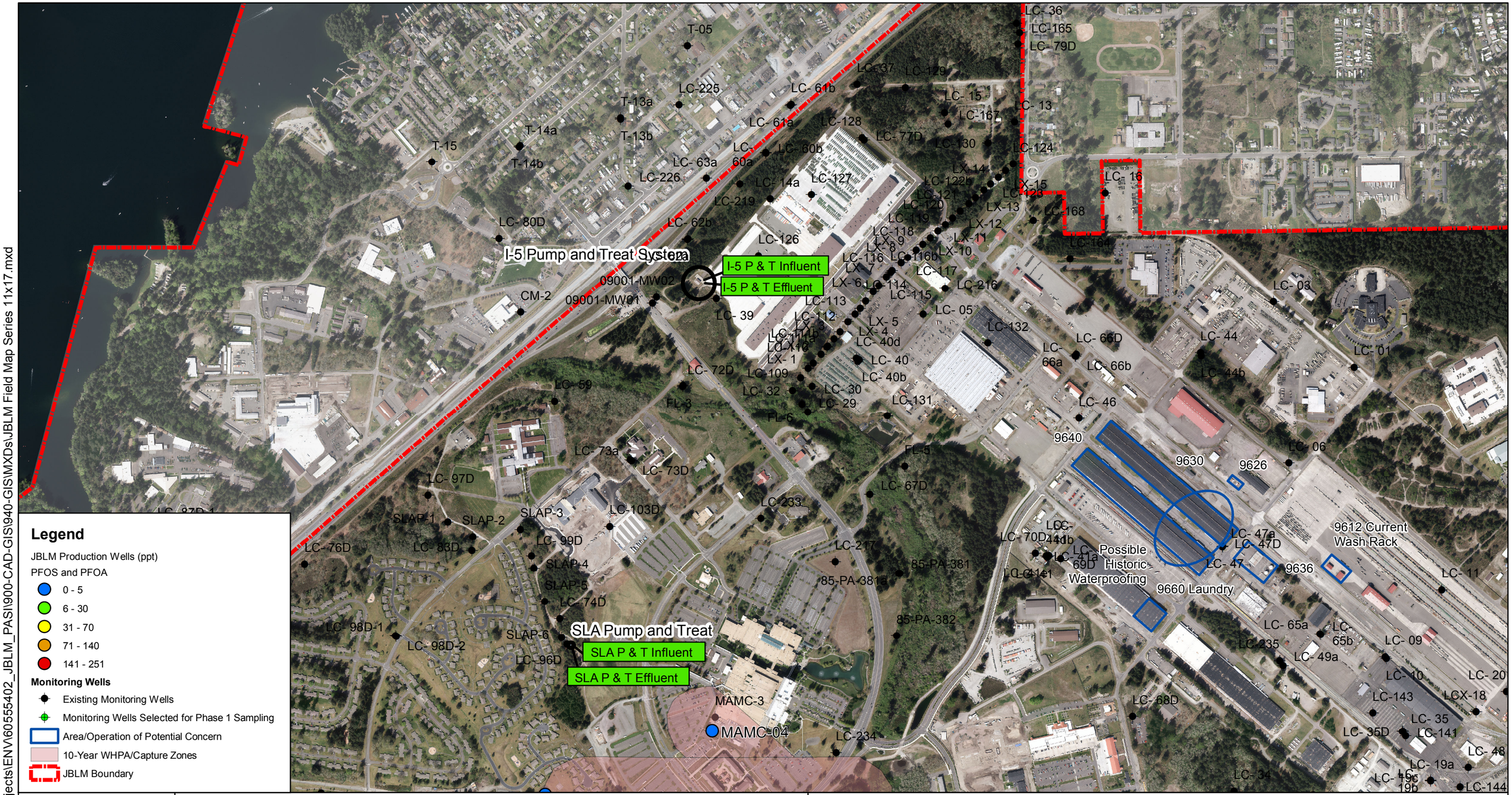

Legend

JBLM Production Wells (ppt)

PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.2 0.4 0.8 Miles

Figure 17-11
Phase 1 Sampling Locations
I-5 and SLA P&T Systems
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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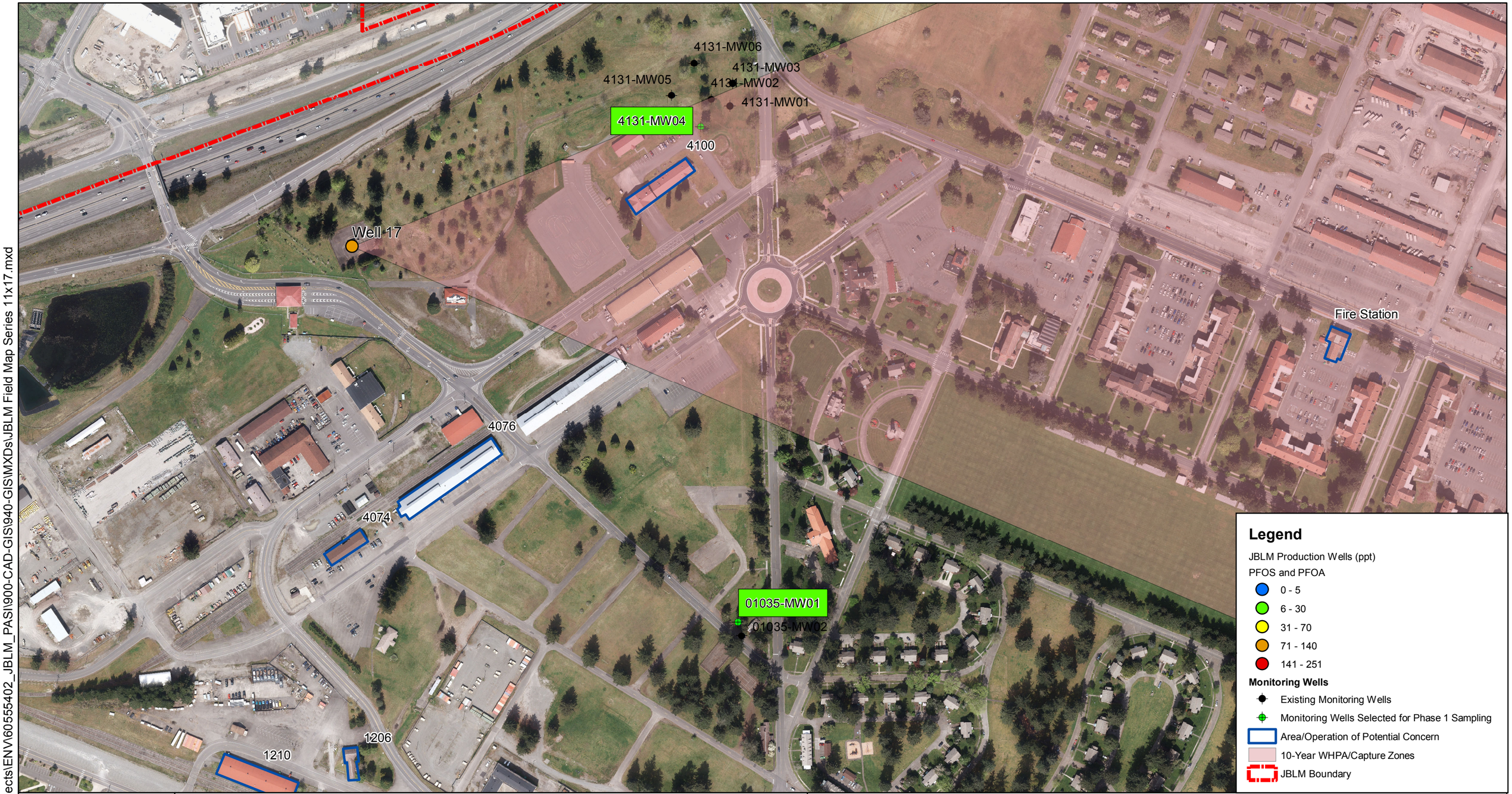

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Figure 17-12
Phase 1 Sampling Locations
Historic Waterproofing/Laundry Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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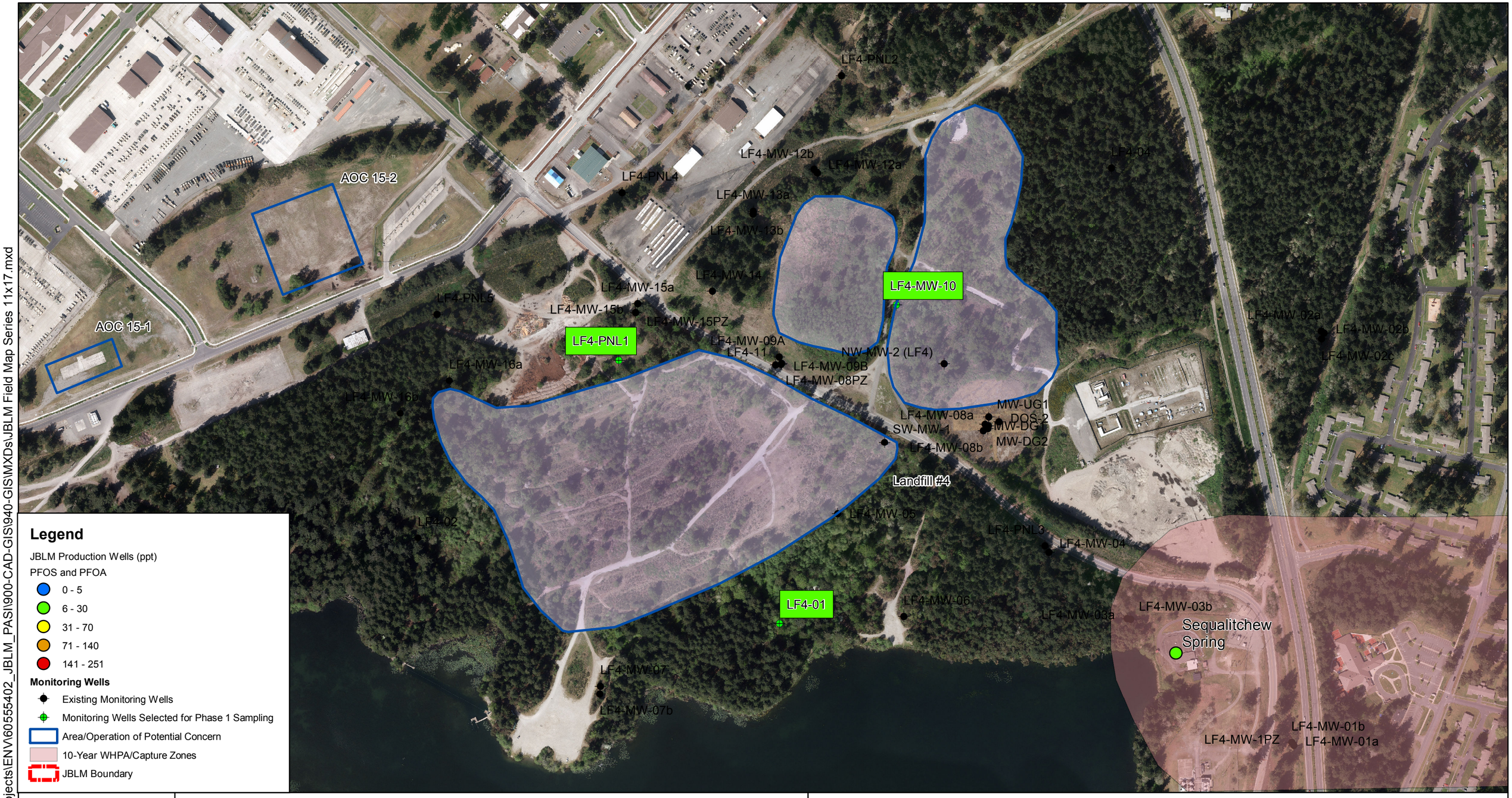

Legend

JBLM Production Wells (ppt)

PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.075 0.15 0.3 Miles

Figure 17-13
Phase 1 Sampling Locations
Landfill #4
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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Sage Well II

Sage Well I

DA- 4b

DA- 4a

Landfill 006

DB- 3

DA- 1b

DA- 1a

Legend

JBLM Production Wells (ppt)

PFOS and PFOA

- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells

- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Area/Operation of Potential Concern
- 10-Year WHPA/Capture Zones
- JBLM Boundary

JOINT BASE LEWIS-McCHORD WASHINGTON PUBLIC WORKS

N

0 0.05 0.1 0.2 Miles

Figure 17-14
Phase 1 Sampling Locations
Landfills 005/006
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

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Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

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QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Production Well	Sampling SOP Reference[a]	Figure Reference
LT-4	Groundwater	16.3 - 26.3	14 PFAS Compounds	1	North McChord Hangars and Runways	North Well	A,B and Worksheet #17	17-1
CW-62	Groundwater	30-40	14 PFAS Compounds	1	Clover Creek	North Well	A,B and Worksheet #17	17-3
IW-2	Groundwater	35 - 45	14 PFAS Compounds	1	Clover Creek and McChord Hangars	North Well	A,B and Worksheet #17	17-2, 17-3
CW-64	Groundwater	45 - 60	14 PFAS Compounds	1	Clover Creek and McChord Hangars	North Well	A,B and Worksheet #17	17-2, 17-3
1168-MW01	Groundwater	7 - 22	14 PFAS Compounds	1	North McChord Hangars and Runways	North Well	A,B and Worksheet #17	17-1
CR-01	Groundwater	8 - 38	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-2
CW-29B	Groundwater	18 - 23	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-2
CW-4	Groundwater	16.9 - 26.9	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-3
Surface Water 1	Surface water	n/a	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,E and Worksheet #17	17-2
FTA-4a	Groundwater	16 - 26	14 PFAS Compounds	1	FT032	East Well	A,B and Worksheet #17	17-6
FTA-4b	Groundwater	68 - 78	14 PFAS	1	FT032	East Well	A,B and	17-6

QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table (Continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Production Well	Sampling SOP Reference[a]	Figure Reference
			Compounds				Worksheet #17	
IH-1a	Groundwater	32.8 - 37.8	14 PFAS Compounds	1	Landfill 013	East Well	A,B and Worksheet #17	17-6
IH-1b	Groundwater	51.8 - 56.8	14 PFAS Compounds	1	Landfill 013	East Well	A,B and Worksheet #17	17-6
IH-3b	Groundwater	52.8 - 57.8	14 PFAS Compounds	1	Landfill 013	East Well	A,B and Worksheet #17	17-6
LT-9	Groundwater	130 - 140	14 PFAS Compounds	1	FT032 and Landfill 013	East Well	A,B and Worksheet #17	17-6
CW-15d	Groundwater	255.4 - 265.4	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-4
CW-15c	Groundwater	98.6 - 108.6	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-4
MF-1	Groundwater	4.5 - 19.5	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-2
CW-14a	Groundwater	25 - 35	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	South Well	A,B and Worksheet #17	17-4
CW-14c	Groundwater	159.5 - 169.5	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	South Well	A,B and Worksheet #17	17-4
CW-14d	Groundwater	265 - 275	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	South Well	A,B and Worksheet #17	17-4

QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table (Continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Production Well	Sampling SOP Reference[a]	Figure Reference
DA-7e	Groundwater	115 - 125	14 PFAS Compounds	1	Landfill 005	MARS Hill	A,B and Worksheet #17	17-8
DA-21a	Groundwater	27.6 - 32.6	14 PFAS Compounds	1	Landfill 005	MARS Hill	A,B and Worksheet #17	17-8
DO-2	Groundwater	40 - 70	14 PFAS Compounds	1	Landfill 005	Housing Well I	A,B and Worksheet #17	17-8
DO-5b	Groundwater	13 - 18	14 PFAS Compounds	1	Landfill 005	Housing Well I	A,B and Worksheet #17	17-8
DA-4a	Groundwater	36.6 – 41.6	14 PFAS Compounds	1	Landfill 005/006	Sage Well I	A,B and Worksheet #17	17-14
DA-4b	Groundwater	60.9 – 65.9	14 PFAS Compounds	1	Landfill 005/006	Sage Well I	A,B and Worksheet #17	17-14
LC-23	Groundwater	20 - 45	14 PFAS Compounds	1	Landfill #2	MAMC-04/Sage Well II	A,B and Worksheet #17	17-9
LC-230	Groundwater	24-44	14 PFAS Compounds	1	Landfill #2	MAMC-04/Sage Well II	A,B and Worksheet #17	17-9
LF-2 P&T Influent	Groundwater	n/a	14 PFAS Compounds	1	Landfill #2	MAMC-04	A,B and Worksheet #17	17-9
LF-2 P&T Effluent	Groundwater	n/a	14 PFAS Compounds	1	Landfill #2	MAMC-04	A,B and Worksheet #17	17-9
I-5 P&T Influent	Groundwater	n/a	14 PFAS Compounds	1	Landfill #2	MAMC-04	A,B and Worksheet	17-11

QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table (Continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Production Well	Sampling SOP Reference[a]	Figure Reference
							#17	
I-5 P&T Effluent	Groundwater	n/a	14 PFAS Compounds	1	Landfill #2	MAMC-04	A,B and Worksheet #17	17-11
SLA P&T Influent	Groundwater	n/a	14 PFAS Compounds	1	Landfill #2	MAMC-04	A,B and Worksheet #17	17-11
SLA P&T Effluent	Groundwater	n/a	14 PFAS Compounds	1	Landfill #2	MAMC-04	A,B and Worksheet #17	17-11
84-CD-LF1-1	Groundwater	20 - 60	14 PFAS Compounds	1	Landfill #1/Gray Field Hangars/SWMU 47	Well 14	A,B and Worksheet #17	17-10
84-CD-LF1-4	Groundwater	20 - 60	14 PFAS Compounds	1	Landfill #1/Gray Field Hangars/SWMU 47	Well 14	A,B and Worksheet #17	17-10
LF4-PNL1	Groundwater	22 - 37	14 PFAS Compounds	1	Landfill #4	Sequalitchew Springs/Well 12B	A,B and Worksheet #17	17-13
LF4-01	Groundwater	22 - 28	14 PFAS Compounds	1	Landfill #4	Sequalitchew Springs/Well 12B	A,B and Worksheet #17	17-13
LF4-MW-10	Groundwater	22 - 37	14 PFAS Compounds	1	Landfill #4	Sequalitchew Springs/Well 12B	A,B and Worksheet #17	17-13
4131-MW04	Groundwater	23 - 33	14 PFAS Compounds	1	Historic waterproofing, laundry	Well 17	A,B and Worksheet #17	17-12
01035-MW01	Groundwater	15 - 30	14 PFAS Compounds	1	Historic waterproofing, laundry	Well 17	A,B and Worksheet #17	17-12
CW-12	Groundwater	11 - 21	14 PFAS	1	FT029	East Well	A,B and	17-5

QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table (Continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Production Well	Sampling SOP Reference[a]	Figure Reference
			Compounds				Worksheet #17	
CW-33c	Groundwater	70 - 80	14 PFAS Compounds	1	Landfill 013/FT032	Prime Beef Replacement Well I	A,B and Worksheet #17	17-7
98-IA-MW-08	Groundwater	38 - 43	14 PFAS Compounds	1	SMWU 47	Well 20	A,B and Worksheet #17	17-10

[a]SOP or worksheet that describes the sample collection procedures (see Appendix A).

QAPP Worksheet #19 -- Analytical Methods/SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time	Number of Field Containers Per Location Per Event
Groundwater/Surface Water	14 PFAS Compounds	EPA 537-MOD / LCP-PFC	2 x 250-mL wide-mouth HDPE	0.5 L	Cool to 4°C±2°C	14 days (extraction) 40 days (analysis)	2

QAPP Worksheet #20 -- Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Environmental Samples	No. of Field Duplicates	No. of MS/MSDs	Equipment Rinsate Samples	Total No. of Samples to Lab
Groundwater/Surface Water	14 PFAS Compounds	64	7	4+4 = 8	26	105

QAPP Worksheet #21 -- Project Sampling SOP References

See Appendix A for field SOPs.

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work?	Comments
SOP A	PFAS Sampling	AECOM	All field sampling equipment, clothing, document materials	No	Describes the processes for collecting and handling PFAS environmental media samples
SOP B	Low-Flow Groundwater Purging and Sampling	AECOM	Variable frequency, electric submersible pump, Horiba U52 (or equivalent) meter, inline, flow-through cell, water level indicator		Outline methods and procedures for collecting groundwater samples using low-flow methods
SOP C	Equipment Calibration, Operation, and Maintenance	AECOM	PID	No	Describes the activities and responsibilities of AECOM personnel pertaining to the operating, calibration, and maintenance of equipment used to collect environmental data
SOP D	Field Parameter Measurement	AECOM	Horiba U52 (or equivalent)	No	Describes the activities and responsibilities of AECOM personnel pertaining to the collection environmental field data
SOP E	Surface Water Sampling	AECOM	Grab sampler	No	Outline methods and procedures for collecting surface water samples
SOP F	Permit and Utility Clearance	AECOM	Conductive and inductive utility location devices	No	Describes the process for determining the presence of subsurface utilities and other cultural features (e.g., vault or tank) at locations where planned site activities involve the physical disturbance of subsurface materials
SOP G	Headspace Analysis	AECOM	PID	No	Guidelines for field screening soils for organic vapors
SOP H	Monitoring Well and Piezometer Installation	AECOM	Drilling rig, well materials	No	Describes well installation procedures and requirements

QAPP Worksheet #21 -- Project Sampling SOP References (Continued)

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work?	Comments
SOP I	Monitoring Well Development	AECOM	Electric submersible pump, water level indicator, turbidity meter	No	Outlines methods and procedures for developing monitoring wells
SOP J	IDW Management	AECOM	None	No	Describes activities and responsibilities of AECOM and their subcontractors with regard to management of investigation derived waste
SOP K	Land Surveying	AECOM	Surveying equipment	No	Describes land surveying procedures and requirements.
SOP L	Record Keeping, Logbook, Sample Labeling, and Chain-of-Custody Procedures	AECOM	Logbook, COCs	No	Establishes protocols for AECOM field personnel and their contractors for use in maintaining field and sampling activity records, writing sample logs, labeling samples, ensuring proper sample custody procedures, and completing chain of custody forms
SOP M	Equipment Decontamination	AECOM	Drill bits, drill casing, submersible pumps, grab samplers	No	Describes general methods of equipment decontamination for use by AECOM field personnel and their contractors during field sampling activities

QAPP Worksheet #22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
Photoionization Detector (PID)	Work space vapor monitoring and soil sample field screening	Daily	Manufacturer's guidance	Replace PID	Field Lead	Manufacturer's instructions	
Horiba Groundwater Parameters Meter	Groundwater and surface water	Daily	Manufacturer's guidance	Replace Horiba	Field Lead	Manufacturer's instructions	
Water Level Meter	Groundwater sampling	Daily	Manufacturer's guidance	Manufacturer's specifications	Field Lead	Manufacturer's instructions	
Sampling Pump	Groundwater sampling	Daily	Manufacturer's guidance	Manufacturer's specifications	Field Lead	Manufacturer's instructions	

QAPP Worksheet #23 -- Analytical SOP References Table

Laboratory SOP Number[a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
LCP-PFC	Perfluoroalkyl Substances by High Performance Liquid Chromatography/Tandem Mass Spectrometry (HPLC/MS/MS) Doc ID LCP-PFC, Revision 8, dated 1/15/2018	Definitive	Groundwater / 14 PFAS compounds	HPLC/MS/MS	ALS-Kelso	N

[a]All laboratory SOPs are on file at the laboratory.

QAPP Worksheet #24 -- Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[a]
High pressure liquid chromatography/ tandem mass spectrometry (HPLC/MS/MS)	Mass Calibration	Initially prior to use and after performing major maintenance, as required to maintain documented instrument sensitivity and stability performance	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Entire range must be mass calibrated.	Not applicable	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	Tune Check	When the masses fall outside of the ±0.5 atomic mass unit (amu) of the true value (as determined by the product ion formulas).	Mass assignments of tuning standard within 0.5 amu of true value.	Retune instrument and verify. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tune check repeated. No samples shall be analyzed without a valid tune.	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	Mass Spectral Acquisition Rate	Each analyte, Extracted Internal Standard Analyte, and Injection Internal Standard Analyte	A minimum of 10 spectra scans are acquired across each chromatographic peak.	Not applicable	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	Calibration, Calibration Verification, and Spiking	All Analytes	Standards containing both branched and linear isomers must be used when commercially available. If not available, the total response of the analyte must be integrated (i.e.,	Not applicable	Laboratory Manager, Analyst, or Certified Instrument	LCP-PFC

QAPP Worksheet #24 -- Analytical Instrument Calibration Table (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[a]
	Standards		accounting for peaks that are identified as linear and branched isomers) and quantitated using a calibration curve which includes the linear isomer only for that analyte (e.g., PFOA).		Technician	
HPLC/MS/MS	Ion Transitions (Parent ->Product)	Prior to method implementation.	The chemical derivation of the ion transitions, both those used for quantitation and those used for confirmation, must be documented. Two transitions and the ion transition ratio per analyte shall be monitored and documented with the exception of PFBA and PFPeA. In order to avoid biasing results high due to known interferences for some transitions, the following transitions must be used for the quantification of the following analytes: PFOA: 413 —› 369 PFOS: 499 —› 80 PFHxS: 399 —› 80 PFBS: 299 —› 80 4:2 FTS: 327 —› 307 6:2 FTS: 427 —› 407 8:2 FTS: 527 —› 507 NEtFOSAA: 584 —› 419 NMeFOSAA: 570 —›419 If these transitions are not used, the reason must be technically justified and documented (e.g., alternate transition was used due to observed interferences).	Not applicable	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	Initial	At instrument	The isotopically labeled analog of an	Correct problem, then rerun	Laboratory	LCP-PFC

QAPP Worksheet #24 -- Analytical Instrument Calibration Table (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[a]
	Calibration (ICAL)	set-up and after initial calibration verification (ICV) or continuing calibration verification (CCV) failure, after major instrument maintenance, and prior to sample analysis.	analyte (Extracted Internal Standard Analyte) must be used for quantitation if commercially available (Isotope Dilution Quantitation). If a labeled analog is not commercially available, the Extracted Internal Standard Analyte with the closest retention time to the analyte must be used for quantitation (Internal Standard Quantitation). S/N ratio: ≥10:1 for all ions used for quantification. For analytes having a promulgated standard (i.e., health advisory levels for PFOA and PFOS), the qualitative (confirmation) transition ion must have a signal-to-noise (S/N) ratio of ≥3:1. The % Relative Standard Deviation of the Response Factor must be <20%. Linear or non-linear calibrations must have $r^2 \geq 0.99$ for each analyte. Analytes must be within 70-130% of their true value for each calibration standard. No samples shall be analyzed without a passing ICAL. Isotope Dilution or Internal Standard Calibration is required for all analytes. External Calibration is not allowed. Calibration can be linear (minimum of 5 standards) or quadratic (minimum of 6 standards).	ICAL.	Manager, Analyst, or Certified Instrument Technician	

QAPP Worksheet #24 -- Analytical Instrument Calibration Table (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[a]
			Weighting is allowed.			
HPLC/MS/MS	ICV	Once after each ICAL and analysis of a second-source standard prior to sample analysis.	All reported analytes within ± 30% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL. No samples shall be analyzed until calibration has been verified.	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	CCV	Prior to sample analysis, after every 10 field samples, and at the end of the analytical sequence.	Concentrations of analytes must range from the LOQ to the mid-level calibration concentrations. All reported analytes must be within ± 30% of true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, or if two consecutive CCVs cannot be analyzed, perform corrective action(s) and reanalyze all affected samples since the last acceptable CCV. Alternatively, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV. Results may not be reported without valid CCVs. The Instrument Sensitivity Check (ISC) can serve as a bracketing CCV.	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	ISC	Prior to analysis and at least once every 12 hours.	Analyte concentrations must be at the LOQ. Concentrations must be within ±30% of their true values.	Correct problem. Rerun ISC. If that fails, repeat ICAL. No samples shall be analyzed until ISC has met acceptance	Laboratory Manager, Analyst, or Certified Instrument	LCP-PFC

QAPP Worksheet #24 -- Analytical Instrument Calibration Table (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[a]
				criteria. The ISC can serve as the initial daily CCV.	Technician	
HPLC/MS/MS	Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤½ the LOQ.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If acceptance criteria are not met after the highest standard which is not included in the calibration, the standard cannot be used to determine the highest concentration in samples at which carryover does not occur. If acceptance criteria are not met after sample, additional instrument blanks must be analyzed until acceptance criteria are met. Additional samples shall not be analyzed until acceptance criteria are met. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample remaining. Note: Successful analysis	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC

QAPP Worksheet #24 -- Analytical Instrument Calibration Table (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[a]
				following the highest standard analyzed determines the highest concentration that carryover does not occur. The highest standard analyzed may be analyzed as part of the calibration curve or following the calibration curve. If analyzed following the calibration curve, it is not used to extend out the calibration range; it is only used to document a higher concentration at which carryover still does not occur. If sample concentrations exceed this range, and the sample(s) following exceed this acceptance criteria (>½LOQ), they must be reanalyzed.		

[a]All laboratory SOPs are on file at the laboratory.

QAPP Worksheet #25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument and equipment maintenance logs must be kept to document analytical instrumentation and equipment maintenance, testing, and inspection activities. Instrumentation maintenance and checks are based on instrument performance and monitored through laboratory QC. Maintenance, testing, and inspection will be performed based on the QC results, manufacturer's instructions, and acceptable performance.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
HPLC/MS/MS	Clean Ion Transfer Tube	Not Applicable	Not Applicable	Daily or after noticeable decrease in signal	Not Applicable	Clean	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	Clean Inlet Activity	Not Applicable	Not Applicable	As needed	Not Applicable	Clean	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC
HPLC/MS/MS	Forepump	Not Applicable	Not Applicable	Every 3 months or as needed	Not Applicable	Change oil	Laboratory Manager, Analyst, or Certified Instrument Technician	LCP-PFC

QAPP Worksheet #26 -- Sample Handling System, Documentation Collection, Tracking, Archiving, and Disposal

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Anthony Palmieri/AECOM
Sample Packaging (Personnel/Organization): Anthony Palmieri/AECOM
Coordination of Shipment (Personnel/Organization): Anthony Palmieri/AECOM
Type of Shipment/Carrier: Federal Express or analytical laboratory provided courier
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodian / ALS Kelso
Sample Custody and Storage (Personnel/Organization): Sample Custodian / ALS Kelso
Sample Preparation (Personnel/Organization): Laboratory Technician / ALS Kelso
Sample Determinative Analysis (Personnel/Organization): Laboratory Technician / ALS Kelso
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 days from delivery of final data packages to AECOM
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90 days after analysis.
Biological Sample Storage (No. of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodian / ALS-Kelso
Number of Days from Analysis: 60 days from delivery of final data packages to AECOM.

QAPP Worksheet #27 -- Sample Custody Requirements

The date and time of sample collection and project name and number will be recorded on the sample label; no additional labels may be attached to pre-tared sample containers. A CoC form will be completed by the field geologist/sampler, and each sample will be placed in a shipping container.

The CoC of the physical sample and its corresponding documentation will be maintained throughout the handling of the sample. All samples must be identified, labeled, logged in a CoC form, and recorded in a sample tracking log or field logbook as a part of the procedure to ensure the integrity of the resulting data. The record of the physical sample (location and time of sampling) will be related to the analytical results through accurate accounting of the sample custody. Sample custody applies to both field and laboratory operations. Analytical requests will be identified on the form. The information for each sample provided on the CoC form will duplicate the information provided on the sample label of each sample container. A carbon copy of the CoC form completed by the field team will be submitted to the PM. The original CoC form will be taped to the inside lid of the shipping container with samples before transport to the laboratory. The laboratory will receive the original CoC form plus a carbon copy. The CoC forms will be retained in the project job files by the project Quality Assurance (QA) Officer.

The sampler will be responsible for the care and custody of the samples from the time they are collected until they are transferred to another individual. A sample is under an individual's custody if one or more of the following criteria are met:

- It is in the sampler’s possession.
- It is in the sampler's view after being in possession.
- It is in the sampler's possession and secured to prevent tampering.
- It is in a designated secure area.

The sampler will complete the CoC form for each sample shipment. When transferring custody, the individuals relinquishing and receiving samples will sign, date, and note the time of the exchange on the record. If samples will be transferred to the laboratory by a third-party shipper, the shipping container must be securely sealed and custody seals must be applied before samples are relinquished; the third party shipper is not required to sign the CoC. The custody record will be completed using waterproof ink. Corrections will be made by drawing a single line through the error and initialing and dating the correction. Information will not be erased or rendered unreadable.

When the samples arrive at the laboratory, the laboratory personnel receiving the sample cooler will evaluate the integrity of the samples and sign the CoC form. The laboratory will assign work order numbers to the samples for use in its internal tracking system. Damaged sample containers, sample labeling discrepancies between sample container labels and the CoC form, and analytical request discrepancies will be noted on the CoC form or other sample receipt documentation. The laboratory will contact the AECOM Project Chemist or AECOM PM for resolution of any discrepancies prior to beginning requested analyses. The laboratory will also provide a sample acknowledgment to the AECOM Project Chemist indicating field sample identification, laboratory identification number, and analytical testing logged for each sample.

QAPP Worksheet #27 -- Sample Custody Requirements (Continued)

AECOM will review this information for correctness within 24 hours of receipt and provide feedback to the laboratory. The status of a sample can be checked at any time by referring to the laboratory numbers on the CoC form and the laboratory work order numbers in the logbooks. Both the laboratory and sample numbers will be cited when the analytical results are reported. The laboratory will send the original CoC form and the analytical data package to the Project Chemist or PM.

SOPs and data collection forms have been developed for sample custody, sample labeling, analysis requests, and shipping and tracking procedures. Analytical laboratory sample custody procedures are included in the laboratory QA plans or SOPs, which identify the roles of both the sample custodian and the laboratory coordinator.

QAPP Worksheet #28 -- Laboratory QC Samples Table

Matrix **Groundwater**
Analytical Group **PFOS/PFOA**
Analytical Method/ SOP Reference **537-MOD / LCP-PFC**

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Extracted Internal Standard Analytes	Every field sample, standard, blank, and QC sample.	Added prior to extraction, or for aqueous samples prepared by serial dilution instead of solid-phase extraction (SPE), added prior to analysis. Extracted Internal Standard Analyte recoveries must be within 50% to 150% of the true value.	If recoveries are acceptable for QC samples, but not for field samples, the field samples must be re-prepared and reanalyzed (greater dilution may be necessary). If recoveries are unacceptable for QC samples, correct the problem, and reanalyze all associated failed field samples. Apply flags and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner.	Analyst, Laboratory QA Officer, or Project Chemist	Accuracy/bias and precision	QC acceptance criteria at least as stringent as specified by DoD QSM 5.1
Method Blank (MB)	One per preparatory batch (up to 20 samples).	No analytes detected > ½ LOQ or > 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required, re-prepare and reanalyze MB and all QC samples and field samples processed with the contaminated blank. Results may not be reported without a valid MB. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply flags for all results for the specific analyte(s) in all samples in the associated preparatory batch.	Analyst, Laboratory QA Officer, or Project Chemist	Sensitivity/bias	QC acceptance criteria at least as stringent as specified by DoD QSM 5.1

QAPP Worksheet #28 -- Laboratory QC Samples Table (continued)

Matrix **Groundwater**
Analytical Group **PFOS/PFOA**
Analytical Method/ SOP Reference **537-MOD / LCP-PFC**

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Laboratory Control Sample (LCS)	One per preparatory batch (up to 20 samples).	Blank spiked with all analytes at concentrations ≥ LOQ and ≤ the mid-level calibration concentration. See Table 28-1 for control limits.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Results may not be reported without a valid LCS. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative.	Analyst, Laboratory QA Officer, or Project Chemist	Accuracy/bias	See Table 28-1
MS/MSD	One per preparatory batch (up to 20 samples)	Samples spiked with all analytes at concentrations ≥ LOQ and ≤ the mid-level calibration concentration. Relative Percent Difference (RPD) ≤30% (between MS and MSD) See Table 28-1 for control limits.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. The data shall be evaluated to determine the source of the difference. For the specific analyte(s) in the parent sample, apply flags if acceptance criteria are not met and explain in the Case Narrative.	Analyst, Laboratory QA Officer, or Project Chemist	Accuracy/bias and precision	See Table 28-1

QAPP Worksheet #28 -- Laboratory QC Samples Table (continued)

Matrix **Groundwater**
Analytical Group **PFOS/PFOA**
Analytical Method/ SOP Reference **537-MOD / LCP-PFC**

QC Sample:	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Post-Spike Sample	Applicable only to aqueous samples prepared by serial dilution instead of SPE with concentrations < LOQ for analyte(s).	Spike aliquot(s) of sample at the final dilution (s) reported for sample with all analytes with concentrations <LOQ in the final dilution. The spike must be at the LOQ concentration to be reported with the sample (the <LOQ value). When analyte concentrations are calculated as <LOQ, the spike must recover within 70-130% of its true value.	When analyte concentrations are calculated as <LOQ, results may not be reported without acceptable post-spike recoveries. When analyte concentrations are <LOQ, and the spike recovery does not meet the 70-130% acceptance criteria, the sample, sample duplicate, and post-spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met.	Analyst	Accuracy/bias	70-130%

QAPP Worksheet #28 -- Laboratory QC Samples Table (continued)

Table 28- 1
Quality Control Criteria for Data Quality Assessment—PFOS/PFOA in Groundwater

Method	Analyte	Water		
		Lower Control Limit (%)[a]	Upper Control Limit (%)[a]	RPD Limit (%)
Surrogate Recoveries				
EPA 537-MOD	Perfluoro-n-(1,2,3,4,5-13C5) nonanoic acid	50	150	Not Applicable
	Perfluoro-n-(1,2,3,4-13C4) octanoic acid	50	150	Not Applicable
	Perfluoro-n-(1,2-13C2) decanoic acid	50	150	Not Applicable
	Perfluoro-n-(1,2-13C2) hexanoic acid	50	150	Not Applicable
	Perfluoro-n-(1,2-13C2) dodecanoic acid	50	150	Not Applicable
	Perfluoro-n-(1,2-13C2) undecanoic acid	50	150	Not Applicable
	Sodium perfluoro-1-(1,2,3,4-13C4)octanesulfonate	50	150	Not Applicable
	Sodium perfluoro-1-hexane(18O2)sulfonate	50	150	Not Applicable
	6:2 Fluorotelemer sulfonate	50	150	Not Applicable
	2-(N-ethyl-d5-perfluoro-a-octanesulfonamido)-ethanol	50	150	Not Applicable
	Ethyl-d5-perfluoro-1-octanesulfonamide	50	150	Not Applicable
	2-(N-methyl-d3-perfluoro-a-octanesulfonamido)-ethanol	50	150	Not Applicable
	Perfluoro-n-[1,2,3,4-13C4]butanoic acid	50	150	Not Applicable
LCS/MS/MSD Recoveries				
EPA 537.1	N-Ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	70	130	30
	N-Methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	70	130	30
	Perfluorobutane sulfonic acid (PFBS)	70	130	30
	Perfluorodecanoic acid (PFDA)	70	130	30
	Perfluorododecanoic acid (PFDoA)	70	130	30
	Perfluoroheptanoic acid (PFHpA)	70	130	30
	Perfluorohexane sulfonic acid (PFHxS)	70	130	30

QAPP Worksheet #28 -- Laboratory QC Samples Table (continued)

Method	Analyte	Water		
		Lower Control Limit (%)[a]	Upper Control Limit (%)[a]	RPD Limit (%)
	Perfluorohexanoic acid (PFHxA)	70	130	30
	Perfluorononanoic acid (PFNA)	70	130	30
	Perfluorooctane sulfonic acid (PFOS)	70	130	30
	Perfluorooctanoic acid (PFOA)	70	130	30
	Perfluorotetradecanoic acid (PFTA)	70	130	30
	Perfluorotridecanoic acid (PFTrDA)	70	130	30
	Perfluoroundecanoic acid (PFUnA)	70	130	30

Notes: [a] Control limits provided by ALS-Kelso and are compliant with DoD QSM v5.1.

QAPP Worksheet #29 -- Project Documents and Records Table

Document	Where Maintained
Field Records: Field logbooks, borehole logs, CoC records/forms, QAPP deviations communications and reports, and photographs	Maintained at AECOM until after completion of the project. Files will be archived at Iron Mountain in Kent, Washington, and submitted to the USACE for archive where applicable.
Laboratory Analytical Records: Raw and summary data, CoC and sample receipt forms, and sample and instrument logs	Maintained at AECOM until after completion of the project. Files will be archived at Iron Mountain in Kent, Washington, and submitted to the USACE for archive.
Data Assessment and QA Records: Data validation report, independent technical review forms, and corrective action communications and reports	Maintained at AECOM until after completion of the project. Files will be archived at Iron Mountain in Kent, Washington, and submitted to the USACE for archive where applicable.
Reports: Drafts, final reports, and communications of progress and deviations	Maintained at AECOM until after completion of the project. Files will be archived at Iron Mountain in Kent, Washington.

QAPP Worksheet #30 -- Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization	Backup Laboratory/ Organization
Groundwater/Surface Water	14 PFAS Compounds	See Worksheet #17, Figures 17-1 through 17-14, and Worksheet #18	537.1	30 calendar days	ALS-Kelso	Vista Analytical

QAPP Worksheet #31 -- Planned Project Assessments Table

Field notes will be reviewed and evaluated for deviations with respect to this QAPP and the field sampling SOPs subsequent to completion of the field effort, and any discrepancies significantly affecting the quality of the project will be discussed in the project report.

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
No project specific assessments are planned[a]	NA	NA	NA	NA	NA	NA	NA

[a]Laboratories will have current DoD-ELAP accreditation.

Notes:
NA – Not applicable.

QAPP Worksheet #32 -- Assessment Findings and Corrective Action Responses

Corrective actions will be defined by the AECOM PM and AECOM QA Manager. The JBLM and USACE PMs will be informed of nonconformances and corrective actions as soon as possible and apprised of any issues that impact project objectives, schedule, or budget. If any nonconformances are found in the field procedures, sample collection procedures, field documentation procedures, laboratory analytical and documentation procedures, and data evaluation and quality review procedures, the impact of those nonconformances on the overall project QA objectives will be assessed. Appropriate actions, including recalibration of equipment, preparation of documentation for deviations, reanalysis, and potentially resampling of a sampling location, may be recommended by the AECOM PM so that the project objectives can be accomplished.

Upon completion of the corrective action, the AECOM QA Manager will evaluate the adequacy and completeness of the action taken. If the action is found to be inadequate, the AECOM QA Manager and AECOM PM will confer to resolve the problem and determine any further actions.

Implementation of any further action will be scheduled by the AECOM PM. The AECOM QA Manager will issue a suspend or stop-work notice with the concurrence of the AECOM PM and the USACE PM in cases where significant problems continue to occur or a critical situation requires work to prevent further discrepancies, loss of data, or other problems. When the corrective action is found to be adequate, the AECOM QA Manager will notify the AECOM PM of the completion of the corrective action.

QAPP Worksheet #33 -- QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data review report	One time at completion of analysis and receipt of laboratory report	On or about July 28, 2018, and November 7, 2018.	Laura Soeten, LDC	AECOM Chemist or AECOM PM, USACE for archive.

QAPP Worksheet #34 -- Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification
Field logbooks	Field logbooks will be written in ink unless field conditions preclude use. The logbooks will be reviewed for proper daily entries, such as dates, names of personnel, and weather, and for completeness. In addition, items not understood will be reviewed with the author.	Internal	AECOM Field Team Lead AECOM PM
CoC forms	CoC forms will be reviewed against cooler contents. The CoC will be signed and the original will be shipped to the laboratory within the cooler. The copy will be kept in project files.	Internal	AECOM Field Team Lead
Sample acknowledgment	The sample acknowledgment generated by the laboratory will be reviewed against the CoC for accuracy and for potential analytical issues.	External	AECOM Project Chemist
Laboratory data package	Prior to submittal to AECOM, the laboratory will review the laboratory data and associated pages for completeness and technical readiness.	External	ALS Kelso QA Manager
Laboratory data package/electronic data	The laboratory and electronic data will be reviewed by AECOM to confirm all sample analyses requested have been provided and that all of the required information for validation has been included in the data package. AECOM will also compare the electronic data to the hard-copy report for consistency.	External	AECOM Project Chemist

QAPP Worksheet #35 -- Validation (Steps IIa and IIb) Process Table

Step IIa/IIb[a]	Validation Input	Description	Responsible for Validation
IIa	SOPs, QAPP	Examine field logbooks and CoCs to ensure sample collection was performed per the plan. Determine impacts of any deviations of sample collection.	AECOM Field Team Lead AECOM Project Chemist AECOM PM
	CoC	Examine CoC records against QAPP requirements, such as analytical methods, sample identification, etc.	AECOM Project Chemist
IIb	Laboratory data package	Examine laboratory package against QAPP requirements and CoC (sample identification, holding times, quality control samples, field duplicates, analytical methods, reporting limits, etc.).	Data Validator AECOM Project Chemist
	Laboratory data package	Determine impacts of any deviations or quality issues associated with analytical data.	Data Validator AECOM Project Chemist AECOM PM
	Reporting limits	Determine whether reporting limits were achieved as identified in Worksheet #12.	Data Validator AECOM Project Chemist AECOM PM

[a]IIa – Compliance with methods, procedures, and contracts (see 10, page 117, UFP-QAPP Manual, V.1 [EPA 2012])
IIb - Comparison with measurement performance criteria in the QAPP (see 11, page 118, UFP-QAPP Manual, V.1 [EPA 2012])

QAPP Worksheet #36 -- Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa	Groundwater/Surface Water	14 PFAS Compounds	Worksheets #12, #19, #24, and #28	Laboratory Data Consultants[a]

[a]Data validation will be conducted by an entity that is provided a copy of this QAPP such that the data will be reviewed in the context of EPA Method 537-Modified and the DoD QSM (USDoD 2017) requirements. Data validation will also take into consideration the measurement criteria specified in this QAPP.

QAPP Worksheet #37 -- Usability Assessment

The data analysis for the sampling event will include a data usability assessment, wherein all data generated will be reconciled with the objectives presented in Worksheet #11. The assessment will describe the initial project objectives and summarize any changes made to the objectives as the project progressed. The rationale for the changes will be discussed, together with any consequences of these changes. The assessment will describe any limitations on the use of the data and how issues were resolved. The assessment will also summarize the procedures used to define data usability (i.e., data reviews or validation reports) and the results of these procedures. The AECOM Project Chemist and AECOM PM will be responsible for determining data usability.

Analytical data will be assessed for precision, accuracy, completeness, representativeness, and comparability by the independent data validator, and the validator's assessment will be reviewed by the AECOM Project Chemist. The data assessment criteria are described in Worksheet #s 12, 15, 24, and 28 of this QAPP, which establish the methods for calculating precision and accuracy and evaluating bias. Completeness, representativeness, and comparability will be evaluated using the methods described in EPA guidance (EPA 2012). The project goal for completeness is 90% and will be calculated as follows:

- Percent Completeness = (number of valid measurements)/(total number of measurements planned) x 100

Generally, data that do not meet the established acceptance criteria are cause for resampling and reanalysis. However, in some cases, data that do not meet acceptance criteria are usable with specified limitations. Data that are indicated as usable with limitations are included in the project reports, but are clearly indicated as having limited usability. Indicators of data limitations include data qualifiers, quantitative evaluations, and narrative statements regarding potential bias.

All data validation will be conducted following the criteria included in this project-specific QAPP, the most recent version of EPA's Functional Guidelines for Organic Methods Data Review, the most recent version of the DoD Quality Systems Manual (QSM), and the analytical method and laboratory SOP requirements.

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APPENDIX A

AECOM Standard Operating Procedures

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CONTENTS

STANDARD OPERATING PROCEDURES

SOP A PFAS Sampling
SOP B Low-Flow Groundwater Purging and Sampling
SOP C Equipment Calibration, Operation, and Maintenance
SOP D Field Parameter Measurement
SOP E Surface Water Sampling
SOP F Permit and Utility Clearance
SOP G Headspace Analysis
SOP H Monitoring Well and Piezometer Installation
SOP I Monitoring Well Development
SOP J IDW Management
SOP K Land Surveying
SOP L Record Keeping, Logbook, Sample Labeling, and Chain-of-Custody Procedures
SOP M Equipment Decontamination

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AECOM

SOP A
PFAS Sampling

Prepared by: AECOM Global PFAS Practice
February 2017

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1 Introduction, Purpose, and Objectives

Poly- and perfluoroalkyl substances (PFAS) are a class of hundreds of compounds that contain chains of various lengths of fluorine-carbon bonds. Fluorine-carbon bonds are one of the strongest bonds in nature; therefore, these compounds have distinct properties of strength, durability, heat-resistance and stability. PFAS are used in the manufacturing of intermediary products and hundreds of articles of commerce used in electronics, aerospace/defense, building/construction, alternative energy, automotive, semiconductors, military, healthcare, outdoor apparel/equipment and chemical/pharmaceutical manufacturing, and most notably in aqueous film forming foams (AFFF) used for fire training and firefighting (https://fluorocouncil.com/PDFs/Infographic-FluoroTechnology-Makes-Important-Products-for-Vital-Industries-Possible.pdf)

Included in these hundreds of articles of commerce that may contain residual PFAS are many items typically found in the sampling environment. These can be divided into two basic categories: 1) the sampling equipment and 2) the items within the sampling environment not related to the sampling equipment. The sampling equipment includes items such as bailers, pumps, tubing, sample jars and lids, gloves, sharpies, decontamination liquids and equipment, metal scoops, aluminum foil, coated field notebooks, etc. Items within the sampling environment not related to the sampling equipment include, but are not limited to, stain- and water-resistant fabrics found in outerwear and boots and in treated vehicle upholstery, personal care items, sunscreens and insect repellants, food wrappers/containers, residual fabric softeners on washed clothing, etc. What complicates evaluation of the PFAS contamination potential of items in this second category is the fact that manufacturers of these items have modified the suite of PFAS used and the amounts used in the manufacturing. In many cases, whether a specific item will be a source of PFAS contamination or not is hard to determine; as a precautionary measure, practical elimination of all of these items from the sampling environment is recommended.

Eliminating all items in the sampling environment that may be a potential source of PFAS contamination is particularly important as the various screening criteria and laboratory reporting limits for PFAS compounds are decreasing. For example, the United States Environmental protection Agency (USEPA) May, 2016, Lifetime Health Advisory for two commonly found PFAS compounds, perfluorooctanoic acid (PFOA) and perfluorosulfonic acid (PFOS), separately or combined, is 70 parts per trillion (ppt), New Jersey has a proposed drinking water MCL of 14 ppt for PFOA, and the June 2016 Australian and New Zealand Environment Conservation Council (ANZZECC) draft freshwater (ecological) guideline for PFOS is 0.23 ppt, which is below current laboratory reporting limits.

The purpose of this document is to train all qualified personnel and subcontractors who collect or otherwise handle PFAS environmental media samples or other types of samples for which PFAS analysis is required such as AFFF concentrate, protective clothing and/or concrete infrastructure (secondary containment structures, air strips, pipes, etc.) in AECOM's best practices. In addition, this document is a guidance resource that can be used along with the standard operating procedures (SOPs) for sampling media that are required to be followed for the client's project, or AECOM SOPs, if client SOP requirements do not exist. This document will supplement the AECOM-required training necessary prior to performing PFAS sampling of environmental media.

The objective of this document is to provide, in a single document, guidance on avoiding PFAS contamination during sampling of environmental media and includes the following topics:

- Safety (Section 2)
- Training and Qualifications (Section 3)
- General PFAS Sampling Guidance (Section 4)

2 Safety

As with any field mobilization, it is the responsibility of the field technical lead, Site Safety Officer (SSO), and all field personnel to be aware of the physical, chemical, and biological hazards associated with the particular site. The mitigation of potential hazards should be documented in site-specific Health and Safety Plans (HASPs) and Task Hazard Assessments (THAs) and incorporated into daily tailgate safety meetings to reinforce the message. The ubiquitous nature of PFAS presents several constraints to specific types of personal protective equipment (PPE) that are commonly used to mitigate health and safety concerns.

Field sampling occurring during extreme weather (e.g., rainfall, snowfall or extreme heat) should be conducted while wearing appropriate clothing that will not pose a risk for cross-contamination (see below Section 4.4 on Field Clothing and PPE), but will also ensure the safety of the field personnel. Sampling programs that include PFAS should take these factors into consideration during the planning phase and be aware of field conditions prior to mobilization.

While using proper sampling SOP guidance and PPE, human exposure to PFAS during sampling should be minimized. It is important to note that USEPA Lifetime Health Advisory (May, 2016) listed PFOA and PFOS as hazardous substances and PFAS and established the advisory of 70 ppt for PFOA and PFOS, separately or combined.

3 Training and Qualifications

The AECOM Global PFAS Practice has prepared this written guidance document and a series of PFAS sampling training modules to guide AECOM practitioners on how to properly sample different environmental media at PFAS impacted sites:

- The prepared guidance document and training modules are for internal use only.
- The trained staff will be certified and will be responsible for ensuring that subcontractors at AECOM job sites meet AECOM sampling requirements.
- AECOM PFAS team intends to maintain a consistent practice when sampling for PFAS to avoid unnecessary cross contamination.
- Given that PFAS sampling techniques, understanding of PFAS cross contamination, PFAS analytical methods and regulatory requirements continue to evolve, this AECOM PFAS SOP will be a living document and will be revised and updated on a regular and “as needed” basis.
- Training modules may be updated and field staff may need to be re-certified in the future.

- The AECOM PFAS SOP will include the latest practice of science and engineering related to PFAS sampling, and it may be more stringent than external PFAS sampling guidance.
- AECOM PFAS project managers (PMs) are responsible for communicating with AECOM clients and implementing the PFAS sampling practice according to the client's instruction.

4 General PFAS Sampling Guidance

4.1 Consideration of Sampling Objectives

The overarching objectives of the project will influence the fundamentals of any sampling and analysis program. It is critical that the rationale and approach to a sampling program considers the end use of the data. For instance, sampling a first flush of stagnate pipe water may be appropriate if the data collected is to be used for inclusion in a human health risk assessment as this sample will represent the worst-case scenario (i.e. not the average). It is recommended good practice to consider the project objectives when using this guidance to develop a project-specific sampling and analysis plan.

4.2 Materials to Avoid in the PFAS Sampling Environment

As stated in Section 1.0, there are many potential sources of PFAS cross contamination that may be found in the typical sampling environment, both in the sampling equipment and the items within the sampling environment not related to the sampling equipment. The list of these items will change based on the specific media that you are sampling.

In general, however, there are known items and material of construction that should be avoided as they have been shown to be or have the potential to be sources of PFAS cross contamination. The first list below include those materials of construction that should not be within the sampling environment and terms or phrases that AECOM personnel can check for that may indicate that a particular item may be a potential PFAS contamination source. The second list below includes materials of construction that have been proven to not be sources of potential PFAS contamination for which AECOM personnel can check for when selecting an item that will be within the sampling environment.

4.2.1 Materials That Should not be in the Sampling Environment

- Polytetrafluoroethylene (PTFE)
- Teflon® and Teflon containing materials
- Low-density polyethylene (LDPE)
- Glass
- Tyvek® or coated Tyvek
- Gore-Tex®

- Decon-90
- Fluoro-surfactants
- Any item in the ingredient list that includes the term “fluoro”

4.2.2 Materials that can be in the Sampling Environment

- High-density polyethylene (HDPE)
- Polypropylene (PP)
- Polyurethane
- Polyvinyl chloride (PVC)
- Silicon
- Alconox®
- Citronex®
- Nitriles
- Liquinox®
- Neoprene
- Waxed fabric or materials
- methanol

4.2.3 Items That Need to be Evaluated

- Clothing or boots described as waterproof, water-resistant, or stain-treated
- Plumber’s tape
- Internal valves and parts of pumping equipment
- Drilling fluids

If you are unsure about an item that you are considering having in the sampling environment, please consult with the manufacturer of the item, or consult with AECOM PFAS Global Practice resource or an AECOM analytical chemist with PFAS experience prior to using the item within the sampling environment. In addition, as described in Section 4.15, it is highly recommended that an equipment blank be collected from the specific item in question prior to use in a sampling event. In addition, it may be prudent to send a section or piece of the equipment (if practical) to the laboratory for leachate analysis.

4.3 Equipment and Supplies

Equipment and supplies typically used during environmental sampling may contribute PFAS contamination to the samples collected. The bullets below provide guidance on equipment to be used and avoided during PFAS sampling and handling.

- Do not use polytetrafluoroethylene (i.e., Teflon) containing materials (e.g., Teflon tubing, bailers, tape, plumbing paste, or other Teflon materials) because Teflon contains fluorinated compounds.

- Low-density polyethylene (LDPE) materials are also not acceptable for sampling.
- Before sampling, check pump materials (check valves, O-rings, and values) for parts made of fluoropolymer materials and replace with high-density polyethylene (HDPE) parts.
- HDPE, PP, silicon materials, and stainless steel are acceptable for sampling equipment (e.g., bottles, unlined screw caps, tubing, hydrasleeves, spoons, bowls).
- Do not use waterproof field books (Rite in the Rain®) as these may contain a plastic coating or adhesive containing PFAS.
- Field notes should be documented on loose paper on Masonite or aluminum clipboards (i.e. plastic clipboards, binders, or spiral hard cover notebooks are not acceptable).
- Post-It Notes® are not allowed on project sites.
- Sharpies® and similar markers should not be used in PFAS sampling events.
- Ball point pens can be used when documenting field activities in field notebooks or on field forms, as well as, labeling sample containers and preparing chains of custody (CoC).
- Do not use chemical (blue) ice packs during the sampling program. This includes the use of ice packs for the storage of food if allowed at the site, and/or samples.
- Ziploc© bags are acceptable for use as ice containers.
- Do not use aluminum foil or recycled paper towels during sampling or sample handling.
- Do not use a vehicle with seat covers with water proofing or stain-resistant coatings such as Scotch Guard.

Again, if you are unsure about an item that you are considering having in the sampling environment, please consult with the manufacturer of the item, or consult with AECOM PFAS Global Practice resource, or an AECOM analytical chemist with PFAS experience prior to using the item within the sampling environment. In addition, as described in Section 4.15 below, it is highly recommended that an equipment blank be collected from the specific item in question prior to use in a sampling event.

4.4 Field Clothing and PPE

While preparing for sampling or sample handling, be particularly suspicious of clothing and PPE that refers to waterproof, water-repellant or stain resistant characteristics as these properties may reflect the use of PFAS in the manufacture of these articles. (see Section 4.1 for a list of materials which are known to be sources of PFAS cross contamination.)

- Do not wear water-resistant, waterproof, or stain-treated clothing during the field program.
- Outerwear made of PVC or wax-coated fabrics may be worn in rainy or cold weather.
- Neoprene may be worn in situations of extreme cold.
- Field clothing made of synthetic and natural fibers (preferably cotton) are acceptable alternatives.
- Do not wear clothing or boots containing Gore-Tex while sampling or sample handling as it contains a PFAS membrane.
- All safety footwear will consist of steel-toed boots made with polyurethane and PVC.
- If the only safety footwear available is treated with water-resistant, waterproof, or stain-treated coating, then outer over boots made of PVC may be worn. The over boots must be put on and the hands washed after putting the over boots on prior to the beginning of the sampling activities. Over boots may only be removed in the staging area and after the sampling activities have been completed.
- Hip waders should be made of PVC.
- Do not wear Tyvek suits and clothing that contains Tyvek as it contains fluorinated compounds.
- Field clothing should be well laundered (a minimum of six times from time of purchase) as new clothing may be treated with PFAS-containing fabric treatments.
- Do not wear clothing that has been washed with fabric softener as fabric softeners may contain PFAS.
- In addition to water-resistant and waterproof clothing, chemical treated clothing for insect resistance and UV protection should also be avoided for PFAS sampling programs. However, this particularly poses a health and safety hazard given the prevalence of biologic hazards (e.g., ticks) and risks to prolonged sun exposure. Acceptable alternatives are provided below:
  - Field personnel should tuck pant legs into socks and/or boots and use duct tape to reduce the risk of being bitten by ticks.
  - Light colored shirts and pants should be worn to easily identify ticks during field activities.
  - Light colored clothing, long sleeves, and large-brimmed hats should also be worn to prevent sunburn.

  - Additional details pertaining to acceptable personal care products (e.g., sunscreen, insect repellants) are available in Section 4.12.

- Well washed (washed six times or more) cotton coveralls may be worn over other clothing if there are concerns with items of clothing being a potential PFAS cross-contamination source. If well washed cotton coveralls are worn, they are to be donned in the staging area prior to sampling. Hands must be washed after donning the coveralls, and powderless nitrile gloves must be worn during sample collection. Coveralls must also only be removed in the staging area after the sampling event has ended.

4.5 Sample Containers and Handling

Laboratories must have demonstrated awareness and remediation of possible cross contamination from equipment and supplies in the laboratory, including the supplying sample containers appropriate for PFAS sampling.

- Powderless nitrile gloves must be worn at all times while collecting and handling samples.
- Samples should be collected in HDPE or PP bottles fitted with an unlined (no Teflon) HDPE or PP screw cap. This is an especially important point as many laboratories use Teflon-lined bottle caps.
- For larger biota sampling, Ziploc bags should be used and aluminum foil must not be used.
- For other bulk sampling of media, sample containers must be evaluated prior to use.
- LDPE should not be used for sample containers or for passive sampling.
- Glass containers should also be avoided due to potential loss of analyte through adsorption.

4.6 Sample Collection

For all sampling media, the hands must be washed prior to commencing the sampling event and clean powderless nitrile gloves must be put on prior to handling sample containers and equipment. In addition, avoid putting the sample bottle cap or lid down if possible during sample collection.

4.7 Preferential Sampling Sequence

The following text describes a strategy for collection of water samples. The same concept of collecting samples from least to most contaminated locations, if known, applies to all media.

To mitigate potential cross-contamination, drinking water, surface water, and groundwater samples are to be collected in a pre-determined order from least

impacted to more impacted based on previous analytical data. If no analytical data are available, samples are to be collected in the following order:

- Drinking water
- Surface water
- Groundwater
  - First sample the upgradient well(s).
  - Next, sample the well located furthest downgradient of the interpreted or known source.
  - The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.

4.8 Sample Shipment

Sample coolers should be packed with the samples in wet ice (not blue or chemical ice). The completed and relinquished CoC form should be taped to the inside of the cooler lid in a Ziploc storage bag. The cooler should be taped closed with a custody seal and shipped by overnight courier to the PFAS laboratory.

4.9 Recommended Sample Holding Times

The following guidance from EPA Method 537 is provided for drinking water samples:

- Samples must be chilled during shipment and must not exceed 10°C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10°C when the samples are received at the laboratory. Samples stored in the laboratory must be held at or below 6°C until extraction, but should not be frozen.
- Water samples should be extracted as soon as possible but must be extracted within 14 days. Extracts must be stored at room temperature and analyzed within 28 days after extraction.

4.10 General Equipment Decontamination

It is recommended for PFAS sampling that PFAS-free disposable equipment be used. However, if equipment re-use is required, field sampling equipment that is used at each sample location will require decontamination between uses in accordance with AECOM or project field sampling SOP. However, several additional procedures should be followed by field personnel regarding decontamination when sampling for PFAS:

- Alconox, Liquinox, Citronox soap, or methanol is acceptable for use in decontamination because the Safety Data Sheets (SDS) do not list fluoro-surfactants as an ingredient.
- Decon 90 has been analyzed and shown to contain PFAS and therefore must not be used during decontamination activities.

- Prior to use, blank samples should be collected from site water supplies to be used for decontamination water to ensure that it is PFAS-free.
- Equipment to be decontaminated will be rinsed with PFAS-free water and then scrubbed using a plastic scrub brush and one of the recommended decontamination liquids listed above.
- Scrubbed equipment will then be triple rinsed with laboratory certified PFAS-free water or other available water provided it has been determined to be PFAS-free.

4.11 PFAS-Free Water

The laboratory will be asked to provide PFAS-free water to be used as final equipment rinses and to prepare field and equipment blanks during sampling (evaluating the potential for cross contamination). PFAS-free water will be demonstrated by the laboratory by analysis, for example, of method blanks.

As previously recommended, site or water from a public water supply can be used for decontamination purposes if the water has been analyzed and shown to be PFAS-free.

4.12 Personnel Hygiene

Many manufactured sunblock and insect repellants contain PFAS and should not be brought or used on-site. Some clothing alternatives to the use of sunscreen and insect repellant are provided in Section 4.4. If conditions require the use of sunblock and insect repellants, then these products should consist of 100% natural ingredients. The following products available within the United States are acceptable for use as sunscreen and/or insect repellent when sampling for PFAS:

- Sunscreens: Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, and baby sunscreens that are “free” or “natural”
- Insect Repellents: Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics
- Sunscreen and Insect Repellant: Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion

Sunscreen and insect repellant manufactured outside of the United States must be evaluated on a case-by-case basis.

4.13 Food Considerations

PFAS have commonly been used in the food packaging industry. The Food and Drug Administration in January 2016 banned the use of PFAS with eight or more carbon chains in food packaging materials. However, many food or snack products may still be packaged in wrappers treated with shorter carbon chain PFAS, which were not banned or may still contain PFAS, depending on the age of the packaging of the food item. Therefore, hands must be thoroughly washed after handling fast food, carry-out food, or snacks. Pre-wrapped food or snacks (like candy bars, microwave popcorn, etc.) must not be in the possession of field personnel on-site during sampling. Food and drinks may only be brought on-site and consumed as dictated by the HASP. When field personnel require a break to eat or drink, they should remove their gloves and coveralls, if worn, in the staging area and move to the designated area for food and beverage consumption. When finished, field personnel should wash their hands, and put their coveralls and gloves back on at the staging area, prior to returning to the work area.

4.14 Laboratory Considerations

Laboratories must have the ability to analyze and report PFAS compounds using an isotope dilution method on a liquid chromatograph tandem mass spectrometer (LC-MS-MS), and demonstrate awareness and remediation of possible cross contamination from equipment and supplies in the laboratory, including the LC-MS-MS instrument.

The laboratory quality control procedures for PFAS analysis should include in each preparatory batch (1) a method blank or laboratory reagent blank to be used as a negative control sample, (2) laboratory quality control sample to be used as a positive control sample, (3) a sample matrix spike, and (4) a matrix spike or laboratory duplicate to verify the absence of significant matrix interferences as well as the precision and accuracy of quantitation in the samples matrix.

4.15 Blanks

The use of blanks should be considered if unsure of the composition or suitable nature of equipment and supplies used during PFAS sampling.

- Equipment blanks should be collected by passing laboratory certified "PFAS-free" water over or through decontaminated field sampling equipment prior to the collection of samples to assess the adequacy of the decontamination process and/or to evaluate potential contamination from the equipment used during sampling. Recommended frequency is one blank/day/matrix or one blank/20 samples/matrix, whichever is more frequent. Subject to the sampling conditions, equipment blanks can be collected depending on whether dedicated sampling equipment is being used.

- Field blanks should be collected by pouring laboratory certified "PFAS-free" water into the sampling container in the field, preserving, and shipping to the laboratory with field samples. It is used to assess contamination from field conditions during sampling. Recommended frequency is one blank/day/matrix or one blank/20 samples/matrix, whichever is more frequent.
- Trip blanks should be provided by the laboratory. A laboratory certified "PFAS-free" water vial is provided by the laboratory to the sampling site and transported back to the laboratory without having been exposed to sampling procedures. Typically, a trip blank is only for volatile compounds, but it may be recommended for PFAS sampling to assess cross-contamination introduced from the laboratory and during shipping procedures. Recommended frequency is one blank/cooler containing PFAS samples.

4.16 Visitors

Visitors to the site will only be allowed if approved by the client and in accordance with the APP and must have all necessary site training or other requirement to be on the site. Approved visitors on the site shall remain at least 30 feet from sampling areas, staging areas, and decontamination areas.

PFAS Sampling Checklist

Project No.:
Project Location:
Signature:
Date:

Team Members

Yes	No	Description
		Has AECOM PFAS Sampling guidance been reviewed by all team members?
		Comments:
Yes	**No**	Has AECOM field sampling staff received needed training certification?
		Comments:
Yes	**No**	Was a briefing held for field sampling staff?
		Comments:
Yes	**No**	Were additional PFAS sampling instructions given to field sampling staff?
		Comments:
Yes	**No**	Have personal clothing and PPE requirements been followed by all field sampling staff?
		Comments:
Yes	**No**	Were lotions and sunscreen used for field sampling staff?
		Comment:

Sample Collection

Yes	No	
Yes	**No**	Has a PFAS-free water source been identified?
		Comment
		Source of PFAS-free water:
Yes	**No**	Have all sampling items, parts and equipment been inspected to be free of PFAS?
		Comment:
Yes	**No**	Has sampling location sequence been communicated to avoid cross-contaminations?
		Comment:
Yes	**No**	Have drilling fluids been evaluated and shown to be free of PFAS?
		Comment:
Yes	**No**	Use of PFAS-free decontamination solution?
		Brand name of decontamination solution:
Yes	**No**	Have all field logs, notebooks, pens, labels been inspected, and do they meet AECOM PFAS sampling guidance requirements?
		Comment:
Yes	**No**	Have all sample shipping materials (ice, Ziploc® bags) been inspected, and do they meet AECOM PFAS sampling guidance requirements?
		Comment:
Yes	**No**	Have all blanks arrived at the site and will they be collected to verify cross-contamination?
		Comment:

Document Control

Yes	No	
Yes	**No**	Have all variances from sampling guidance been documented?
		Comment:

Other Comments:

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LOW-FLOW GROUNDWATER PURGING AND SAMPLING

1.0 PROCEDURE

1.1 PURPOSE

This procedure establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples with as little alteration of water chemistry as possible.

1.2 PREPARATION

1.2.1 Site Background Information

A thorough understanding of the purposes of the sampling event should be established prior to commencing field activities. A review of available data obtained from the site and pertinent to the water sampling should also be conducted. Copies of well logs or summary tables regarding well construction information should be available on-site if possible.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that may be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column.

It is highly recommended that the field sampling team is familiar with the U.S. EPA recommended protocols for low-flow sampling outlined in the April 1996 Ground Water Issue *Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures* (U.S. EPA 1996).

1.2.2 Groundwater Analysis Selection

The requisite field and laboratory analyses should be established prior to performing water sampling. The types and numbers of quality assurance/quality control (QA/QC) samples to be collected are specified in the QAPP.

1.3 GROUNDWATER SAMPLING PROCEDURES

Groundwater sampling procedures at a site should include: (1) measurement of depth to groundwater and total depth, (2) assessment of the presence or absence of an immiscible phase (if required by the project plan), (3) assessment of purge parameter stabilization, (4) purging of static water within the well and well bore, and (5) obtaining a groundwater sample. Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events.

1.3.1 Measurement of Static Water Level Elevation

The depth to water and the total depth of the well should be measured to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). Dependent upon individual project requirements, synoptic water level collection may be required prior to groundwater sampling activities. In the event that synoptic water levels **are not** collected prior to sampling activities, total depth measurements should be collected **after** purging and sampling activities to prevent the suspension of fine-grained sediment that may be present at the bottom of the well. Each well should be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed.

An electronic water level meter accurate to 0.01 foot should be used to measure the water level surface and depth of the well. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

1.3.2 Decontamination of Equipment

Each piece of non-dedicated equipment should be decontaminated prior to entering the well. Decontamination should also be conducted prior to the start of sampling at a site, even if the equipment is known to be decontaminated subsequent to its last usage. This precaution is taken to minimize the potential for cross-contamination. In addition, each piece of equipment used at the site should be decontaminated prior to leaving the site. Dedicated sampling equipment need only be decontaminated prior to installation within the well. Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated, and has been evaluated by the project team prior to use can be placed in the well without onsite decontamination.

Further details are presented in SOP M, *Equipment Decontamination*.

1.3.3 Detection of Immiscible Phase Layers

Unless specified in the project plans, groundwater samples should not be collected from wells with detectable amounts of LNAPL and DNAPL.

1.3.4 Purging Equipment and Use

To help minimize the potential for cross-contamination, well sampling should proceed from the least contaminated to the most contaminated. This order may be changed in the field if conditions warrant, particularly if dedicated sampling equipment is used. Tubing must be Teflon®-free. All groundwater removed from potentially contaminated wells should be handled in accordance with the investigation-derived waste (IDW) handling procedures described in SOP J, *IDW Management*.

Purging should be accomplished by removing groundwater from the well at low flow rates using a pump. According to the U.S. EPA (1996), the rate at which groundwater is removed from the well during purging ideally should be between than 0.1 to 0.5 L/min. The pump intake should be placed in the middle of the calculated saturated screened interval. The purge rate should be low enough that substantial

drawdown (>0.3 foot) in the well does not occur during purging. If a stabilized drawdown in the well can't be achieved and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. ***Under no circumstances should the well be pumped dry or otherwise over-purged***. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or groundwater sampling log with a recommendation for a different purging and sampling procedure (USEPA, 2012).

Water level measurements should be collected to assess the water level effects of purging. A low purge rate also will reduce the possibility of stripping VOCs from the water, and will reduce the likelihood of mobilizing colloids in the subsurface that are immobile under natural flow conditions.

Water quality parameters should be collected and recorded on a regular basis (every 3-5 minutes) during well evacuation. Field parameters to be collected may include temperature, pH, specific conductance, salinity, dissolved oxygen, Redox potential, and turbidity. At least seven readings should be taken during the purging process unless the field parameters stabilize more quickly. These parameters are measured to demonstrate that the formation water, not stale well casing water, is being evacuated. Purging should be considered complete when the high and low values between three consecutive field parameter measurements stabilize within 10%. Turbidity may be considered stable if values are less than 10 nephelometric turbidity units (NTUs). The criterion for temperature may not be applicable if a submersible pump is used during purging due to the heating of the water by the pump motor. Field personnel should refer to the QAPP for specific measurement requirements and well stabilization criteria.

All information obtained during the purging and sampling process should be entered into the field logbook. In addition to the field logbook, the data may be logged on a groundwater sampling log. In special situations where LNAPL has been detected in the monitoring well and a groundwater sample is determined to be necessary by the Project Manager, a stilling tube should be inserted into the well prior to well purging. The stilling tube should be composed of a material that meets the performance guidelines for sampling devices. The stilling tube should be inserted into the well to a depth that allows groundwater from the screened interval to be purged and sampled. The bottom of the tube should be set below the upper portion of the screened interval where the LNAPL is entering the well screen. The goal is to sample the aqueous phase (groundwater) while preventing the LNAPL from entering the sampling device. To achieve this goal, the stilling tube must be inserted into the well in a manner that prevents the LNAPL from entering the stilling tube.

One method of doing this is to cover the end of the stilling tube with a membrane or material that will be ruptured by the weight of the pump. The stilling tube is lowered slowly into the well to the appropriate depth and then attached firmly to the top of the well casing. When the pump is inserted, the weight of the pump breaks the membrane covering the end of the tube, and the well can be purged and sampled from below the LNAPL layer. The membrane or material that is used to cover the end of the stilling tube must be fastened firmly so that it remains attached to the stilling tube when ruptured. Moreover, the membrane or material must retain its integrity after it is ruptured. Pieces of the membrane or material must not fall

off of the stilling tube into the well. Stilling tubes should be thoroughly decontaminated prior to each use. Groundwater removed during purging should be collected and stored onsite until its disposition is determined based upon laboratory analytical results. Storage should be in secured containers such as DOT-approved drums. Containers of purge water should be clearly labeled.

1.3.5 Groundwater Sampling Methodology

The well should be sampled when groundwater within it is representative of aquifer conditions and after it has recovered sufficiently to provide enough volume for the groundwater sampling parameters. A period of no more than 2 hours should elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. The water level should be measured and recorded prior to sampling to demonstrate the degree of recovery of the well. Sampling equipment should never be dropped into the well, because this could cause aeration of the water upon impact. In addition, the sampling methodology utilized should allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers.

1.3.6 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs, are chemically unstable, and therefore samples must be preserved. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field team may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Samples should be transferred in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the QAPP.

When sampling for VOCs, water samples should be collected in vials or containers specifically designed to prevent loss of VOCs from the sample. Analytical Laboratories shall provide vials, preferably by the laboratory that will perform the analysis. Groundwater from the sampling device should be collected in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment should not touch the interior of the vial. The vial should be filled above the top of the vial to form a positive meniscus with no overflow. No headspace should be present in the sample container once the container has been capped. To check for headspace, invert the vial, and then tap the side of the vial to dislodge any air bubbles. Sometimes, it is not possible to collect a sample without air bubbles, particularly water that is aerated. In these cases, the investigator should note the problem to account for possible error. Field logs and laboratory analysis reports should note any headspace in the sample container(s) at the time of receipt by the laboratory, as well as at the time the sample was first transferred to the sample container at the wellhead.

1.3.6.1 Special Handling Considerations

Samples requiring analysis for organics should not be filtered. Samples should not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container.

1.3.6.2 Field Sampling Preservation

Samples should be preserved immediately upon collection. Ideally, sample jars contain preservatives of known concentration and volume during the initial filling of the jar to a predetermined final sample volume. For example, metals require storage in aqueous media at pH of 2 or less. Typically, 0.5 ml of 1:1 nitric acid added to 500 ml of groundwater will produce a pH less than 2.0. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. It should be noted that introduction of preservatives will dilute samples, and may require normalization of results. Guidance for the preservation of environmental samples can be found in the EPA "Handbook for Sampling and Sample Preservation of Water and Wastewater:" (U.S. EPA 1982).

2.0 DOCUMENTATION

Information collected during groundwater sampling should be documented in the field logbook in accordance with SOP L, *Field Documentation*. In addition, groundwater sampling purge logs may be may be filled out in addition to the field logbook. Copies of this information should be sent to the Project Manager and to the project files. A groundwater sampling log should be documented in the field logbook and contain the following information:

- Identification of well
- Well depth
- Static water level depth
- Presence of immiscible layers
- Purge volume and pumping rate
- Time that the well was purged
- Collection method for immiscible layers
- Sample IDs
- Well evacuation procedure/equipment
- Date and time of collection
- Parameters requested for analysis
- Field analysis data
- Field observations on sampling event
- Name of collector

Groundwater Sampling Log

Project Number: _____ Date: _____

Location: _____ Time: _____

Well Number: _____ Climatic Conditions: _____

Initial Measurements: Static Water Level: _____
Total Depth: _____

Well Purging: Length of Saturated Zone: _____ linear feet
Volume of Water to be Evacuated: _____ gals./linear ft. x
Linear feet of Saturation x Casing Volumes* = _____ gallons
Method of Removal: _____
Pumping Rate: _____ gallons/minute

Well Purge Data:

DATE/ TIME	GALLONS REMOVED	pH	SP. COND.	D.O.	REDOX	TURBIDITY

Sample Withdrawal Method: _____
Appearance of Sample: Color _____
Turbidity _____
Sediment _____
Other _____

Laboratory Analysis Parameters and Preservatives: _____

Number and Types of Sample Containers Used: _____

Sample ID(s): _____

Decontamination Procedures: _____

Notes: _____

Sampled by: _____
Samples delivered to: _____
Date/Time: _____
Transporters: _____

* Capacity of casing (gallons/linear foot): 2”-0.16, 4”-0.65, 6”-1.47, 8”-2.61, 10”-4.08, 12”-5.87

3.0 REFERENCES

U.S. EPA. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029. September 1982.

U.S. EPA. 1996. Ground Water Issue, Low-flow (Minimal Drawdown) Groundwater Sampling Procedures. EPA/540/S-95/504. April 1996

U.S. EPA. 2012. Standard Operating Procedure Low-Stress (Low Flow) / Minimal Drawdown Ground-Water Sample Collection, USEPA, Region 9, Management and Technical Services Division, April 2012.

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EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE

1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities of personnel pertaining to the operating, calibration, and maintenance of equipment used to collect environmental data. Reliable measurements of data required by the field sampling plan are necessary because the information recorded may be the basis for development of remedial action and responses.

2.0 PROCEDURES

2.1 EQUIPMENT CALIBRATION

All water quality monitoring equipment will be calibrated and adjusted to operate within the manufacturers' specifications. Water quality instruments and equipment that require calibration are to be calibrated to specifications prior to field use. In addition, a one-point calibration check is made at midday and at intervals outlined in the field sampling plan. A final check is conducted at the end of each field day. This is not a recalibration of the meter but a check of the calibration to ensure the continued accuracy of the meter. All calibration information shall be recorded in the project logbook.

Special attention shall be paid to instruments that may be affected by the change in the ambient temperature or humidity. Calibration checks should also be performed when sampling conditions change significantly, a change of sample matrix, and/or readings are unstable or there is a change of parameter measurements that appear unusual.

2.2 EQUIPMENT MAINTENANCE

All field monitoring equipment, field sampling equipment, and accessories are to be maintained in accordance with the manufacturer's recommendations and specifications and/or established field practices. All maintenance will be performed by qualified personnel and documented in the field logbook.

Equipment requiring battery charging shall be charged as recommended by the manufacturer. Backup batteries for meters requiring them shall be included as part of the meters accessories. Care must be taken to protect meters from adverse elements. This may involve placing the meter in a large plastic bag to shield it from the weather.

3.0 DOCUMENTATION

All field equipment calibration, maintenance, and operation information shall be recorded within the field logbook. This is to document that appropriate procedures have been followed and to track the equipment operation. All entries in the field logbook must be written accurately and legibly as outlined in the SOP L, *Field Documentation.*

Logbook entries shall contain, but are not necessarily limited to, the following:

- Equipment model and serial numbers
- Date and time of calibration or maintenance performed
- Calibration standard used
- Calibration lot number and expiration date if listed on bottle
- Calibration procedure used if there are multiple options
- Calibration and calibration check readings including units used
- Problems and solutions regarding use, calibration or maintenance of the equipment
- And other pertinent information

4.0 REFERENCES

SOP L, *Field Documentation*

5.0 ATTACHMENTS

None.

FIELD PARAMETER MEASUREMENTS

1.0 PURPOSE

This standard operating procedure (SOP) provides instructions for the calibration, use, and checking of instruments and equipment for field measurements.

2.0 PROCEDURES

2.1 WATER QUALITY MEASUREMENTS

All field water quality meters shall be calibrated daily following the manufacturers' specifications. Calibration shall be performed prior to using the instrument for collecting parameters. In addition, the meter's calibration should be checked at mid-day and the end of the day to determine if measurements have drifted from the original calibration numbers. These checks are not intended to be a recalibration of the instrument. All calibration and measurement data shall be recorded in the project logbook. Fluids used for calibration shall be changed at regular intervals to ensure its integrity. Since different fluids have different shelf lives and tolerances, manufacturers' specifications should be checked as appropriate.

Most multi-probe water quality meters utilize a flow-through cell. If the unit being used does not have a flow-through cell, a large enough vessel (i.e. polypropylene beaker) in which the probes will be submerged shall be used. The water to be measured will be pumped continuously through the beaker from the bottom, overflowing the top. The flow-through cells will usually allow for quicker stabilization of dissolved oxygen and oxidation-reduction potential readings.

Water shall be allowed to flow continuously through the cell or beaker with water quality measurements being collected at regular intervals, every three to five minutes, until stabilization of the parameters has occurred. A minimum number of seven sets of readings should be collected or as otherwise outlined in the field sampling plan. Stabilization is considered to have occurred when three consecutive readings meet the following guidelines:

pH	+ 0.2 Scientific Units
Specific Conductance	+ 3 % mS/cm
Turbidity	+ 10% or < 10 NTUs
Dissolved Oxygen	+ 10% mg/cm
Salinity	+ 10%
Oxidation-Reduction Potential	+ 10 mV
Temperature	+ 10% °C

In addition to recording the above listed parameters the following information shall also be documented: date, time of measurement, flow rates, purge volumes, total volume purged, and other relative information (i.e. odors, sheen, comments on turbidity, water color)

2.2 ORGANIC VAPORS

Various organic vapor monitors have differing requirements for equipment warm-up and operation. Ensure that all organic vapor monitors are calibrated and operated according to the manufacturer's specification.

For measuring vapors present in soils, expose the monitor to a sample of soil by collecting a sample in sealable polyethylene (e.g., Ziploc®) plastic baggy and placing the probe tip into the closed bag. In cold weather, the soil may need to be warmed prior to testing.

For measuring breathing zone vapors, hold the probe tip in the area of the breathing zone while field activities are being conducted. Take representative measurements from each different work or sampling area.

For monitoring well head space, place the probe tip just inside of the monitoring well casing immediately after removing the cap.

All readings including calibration information shall be recorded in the field logbook.

3.0 DOCUMENTATION

Record all observations and analysis in the field logbook as defined in SOP L, *Field Documentation*. If required by the QAPP, also complete the Field Measurement Data Form.

4.0 REFERENCES

ASTM International. 2003. D6771-02 Standard Practice for Low-flow Purging and Sampling Wells and Devices Used for Groundwater Quality Investigations

SOP L, *Field Documentation*

SURFACE WATER SAMPLING

1.0 PROCEDURES

This SOP describes sample collection methods for a surface water sampling program. Surface water sample locations and specific sampling techniques shall be described in the appropriate project plans. Variations from the procedures described in this SOP may be warranted depending on specific site conditions and chemicals of concern.

Proper selection of sampling points and collection methodology are essential to meeting the objectives of a surface water monitoring program. Sampling points should be selected for collection of surface water samples on the basis of characteristics of the surface water body to be monitored, the location of the body of surface water, and its hydrologic boundaries with respect to the site. Other considerations include the contaminants of concern, logistical considerations such as access to the surface water body, the direction of flow, and determination of a background location.

Methods of collecting surface water samples vary from hand sampling procedures at a single point to sophisticated, multipoint sampling techniques. The number and type of samples to be collected depends on the characteristics of the body of water, the amount of suspended sediment that a moving body carries, the size of the discharge area at the site, and other factors. Multipoint sampling techniques apply to larger bodies of water; the samples are composited to provide a more representative sample.

1.1 GRAB SAMPLER

A dip or grab sample is appropriate for a small body of water, or for collecting near-surface samples in a larger surface water body. The sampling method involves the filling of a sample container by submerging it either just below the surface, or by lowering the container to a desired depth by using a weighted holder. For shallow bodies of surface water, the sample container shall be held carefully just beneath the water surface to avoid disturbing the streambed and stirring the sediment. The container's mouth should be positioned so that it faces upstream, while the sampling personnel are standing downstream. Sampling of rivers, streams, or creeks will be conducted in a downstream to upstream order. Any preservative added to the sample should be added after sample collection to avoid loss of preservative. Alternatively, a transfer device may be dipped into the water and the contents transferred to the appropriate container containing the preservative.

1.2 TRANSFER DEVICES

For deeper surface water bodies, either sample containers or transfer devices may be used to collect a sample. A weighted holder that allows either a sample transfer device or a sample container to be lowered, opened for filling, closed, and returned to the surface is suggested for sampling deeper surface water bodies. This is because concentrations of constituents near the surface of a deeper body of surface water may differ from the total concentration distributed throughout the water column cross-section and thus a surface sample would not be representative of the water body. An open container that is lowered

and raised to the surface at a uniform rate so that the bottle is just filled on reaching the surface is appropriate for deeper stagnant water bodies, however this method does not collect a truly representative sample in deeper flowing surface water bodies.

Whenever possible, the sampling device, either disposable or constructed of a nonreactive material should hold at least 500 ml to minimize the number of times the liquid must be disturbed, thus reducing agitation of any sediment layers. A 1-liter polypropylene or stainless steel beaker with pour spout and handle works well. Any sampling device may contribute contaminants to a sample. The correct sampling device will not compromise the integrity of the sample.

The following procedures are used for samples collected using transfer devices:

1. Submerge a stainless steel dipper or other suitable device, causing minimal disturbance to the surface of the water. Note the approximate depth and location of the sample source (for example, one foot up from bottom or just below the surface).
2. Allow the device to fill slowly and continuously.
3. Retrieve the dipper or device from the surface water with minimal disturbance.
4. Remove the cap (which should be Teflon®-free) from the sample bottle and slightly tilt the mouth of the bottle below the dipper or device edge.
5. Empty the dipper or device slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence.
6. Continue delivery of the sample until the bottle is almost completely filled. Check all procedures for recommended headspace for expansion.
7. If necessary, preserve the sample according to guidelines in the sampling plan. In most cases, preservatives should be placed in sample containers before sample collection to avoid overexposure of samples and overfilling of bottles during collection.
8. Secure the Teflon®-free cap tightly. Tape the cap to the bottle using solvent-free tape; then date and initial the tape. The tape will serve as a custody seal.
9. Label the sample bottle with an appropriate sample tag using a solvent-free marker. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook and complete the chain-of-custody form.

Dismantle the sampler, wipe the parts with terry towels or rags, and store them in plastic bags for subsequent disposal. Follow all instructions for proper decontamination of equipment and personnel.

1.3 WEIGHTED BOTTLE SAMPLER

Collecting a representative sample from a larger body of surface water is difficult but not impossible. Samples should be collected near the shore unless sampling from a boat is feasible and permitted. If a boat is used, the body of water should be cross-sectioned, and samples should be collected at various depths across the water in accordance with the specified sampling plan. For this type of sampling, a

weighted-bottle sampler should be used to collect samples at any predetermined depth. The sampler consists of an HDPE bottle, a weighted sinker, a bottle stopper, and a line that is used to open the bottle and to lower and raise the sampler during sampling. It can be either fabricated or purchased. The procedure for use is as follows:

1. Assemble the weighted bottle sampler.
2. Gently lower the sampler to the desired depth so as not to remove the stopper prematurely.
3. Pull out the stopper with a sharp jerk of the sampler line.
4. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.
5. Raise the sampler and cap the bottle.
6. Wipe the bottle clean. The bottle can also be used as the sample container.

Teflon®-free bailers may also be used to collect samples in deep bodies of water.

1.4 POND SAMPLER

Where cross-sectional sampling is not appropriate, near-shore sampling may be done using a pond sampler. In this instance, a modification that extends the reach of the sampling technician is most practical. The modification incorporates a telescoping, heavy-duty, aluminum pole with an adjustable beaker clamp attached to the end. A disposable HDPE container, or the actual sample container itself, can be fitted into the clamp. If cross contamination is a concern, use a disposable container or the actual sample container.

1.5 PERISTALTIC PUMP

Another method of extending the reach of sampling efforts is to use a peristaltic pump. In this method, the sample is drawn through HDPE tubing and pumped directly into the sample container. This system allows the operator to reach into the liquid body, sample from depth, or sweep the width of narrow streams. However, use of the peristaltic pump is restricted to a maximum depth of 20 to 24 feet due to the physical constraints associated with vacuum pumps.

If medical-grade silicon tubing is used in the peristaltic pump, the system is suitable for sampling almost any analyte, including most organics. Battery-operated pumps of this type are available and can be easily carried by hand or with a shoulder sling. It is necessary in most situations to change both the HDPE suction line and the silicon pump tubing between sample locations to avoid cross contamination. This action requires maintaining a sufficiently large stock of material to avoid having to clean the tubing in the field.

When medical-grade silicon tubing is not available or the analytical requirements are particularly strict, the system can be altered. In this configuration, the sample volume accumulates in the vacuum flask and does not enter the pump. The integrity of the collection system can now be maintained with only the most nonreactive material contacting the sample. Some loss in lift ability will result because the pump is now moving air, a compressible gas, rather than an essentially non-compressible liquid. Also, this system

cannot be used if volatile compounds are to be analyzed. The potential for losing volatile fractions because of reduced pressure in the vacuum flask renders this method unacceptable for use.

This pump works especially well for sampling large bodies of water when a near-surface sample will not sufficiently characterize the body as a whole. It is capable of lifting water from depths in excess (but not much in excess) of 21 feet. It should be noted that this lift ability decreases somewhat with higher density fluids and with increased wear on the silicone pump tubing. Similarly, increases in altitude will decrease the pump's ability to lift from depth. When sampling a liquid stream that exhibits a considerable flow rate, it may be necessary to weight the bottom of the suction line.

For samples collected using peristaltic pumps:

1. Install clean, medical-grade silicon tubing in the pump head, per the manufacturer's instructions. Allow sufficient tubing on the discharge side to facilitate convenient dispensation of liquid into sample bottles but only enough on the suction end for attachment to the intake line. This practice will minimize sample contact with the silicon pump tubing.

2. Select the length of suction intake tubing necessary to reach the required sample depth and attach it to the tubing on the intake side of the pump. If necessary, a small weight composed of relatively inert material, which will not react with anticipated chemicals, may be used to weight the intake tubing.

3. If possible, allow several liters of sample to pass through the system before actual sample collection. Collect this purge volume, and then return it to source (i.e., surface water) after the sample aliquot has been collected.

4. Fill necessary sample bottles by allowing pump discharge to flow gently down the side of bottle with minimal entry turbulence. Cap each bottle as filled.

5. Preserve the sample, if necessary, following guidelines in sampling plan. In most cases, preservatives should be placed in sample containers before sample collection to avoid overexposure of samples and overfilling of bottles during collection.

6. Secure the cap tightly. Tape the cap to the bottle; then date and initial the tape. The tape will serve as a custody seal.

7. Label the sample bottle with an appropriate tag. Be sure to label the tag carefully and clearly, addressing all the categories or parameters. Record the information in the field logbook and complete the chain-of-custody documents.

8. Place the properly labeled sample bottle in an appropriate carrying container.

9. Allow system to drain thoroughly; then disassemble and decontaminate it.

1.6 MULTIPOINT SAMPLING

Samples from various locations and depths can be composited if investigative goals indicate that it is appropriate; otherwise, separate samples will have to be collected. Approximate sampling points should be identified on a sketch of the water body

Multipoint sampling techniques that represent both dissolved and suspended constituents and both vertical and horizontal distributions are applicable to larger bodies of water. Subsequent to sample collection, multipoint-sampling techniques may require a compositing and sub-sampling process to homogenize all the individual samples into the number of subsamples required to perform the analyses of interest. Homogenizing samples is discouraged for samples collected for volatile organic analysis, because aeration causes a loss of volatile compounds. If collection of composite samples is required, then the procedure for compositing shall be included in the project-specific Work Plan or FSP.

The sampling devices selected must not compromise sample integrity. Samples must be collected with either disposable devices, or devices constructed of a nonreactive material such as HDPE or stainless steel. The device must have adequate capacity to minimize the number of times the liquid must be disturbed, reducing agitation of any sediment layers. Further, the device must be able to transfer the water sample into the sample container without loss of volatile compounds. A single- or double-check valve or stainless steel bailer equipped with a bottom discharging device may be utilized.

All equipment used for sample collection must be decontaminated before and after use in accordance with SOP M, *Equipment Decontamination*.

2.0 DOCUMENTATION

During the completion of sampling activities, the sample logbook will be filled out and forms will be transmitted to the Project Manager for storage in project files.

3.0 REFERENCES

SOP M, *Equipment Decontamination*

4.0 ATTACHMENTS

None.

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UTILITY CLEARANCE

1.0 PURPOSE

This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features (e.g., vault or tank) at locations where planned site activities involve the physical disturbance of subsurface materials. The definition of subsurface disturbance varies by base. Each base may have specific required procedures. The SOP applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities. The primary purpose of the SOP is to minimize the potential for damaging underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

2.0 PROCEDURES

The following steps shall be followed at all sites where subsurface exploration will include drilling or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, personnel must always exercise caution while conducting any subsurface exploratory work.

2.1 PREPARE PRELIMINARY SITE PLAN

A preliminary, scaled site plan depicting the proposed exploratory locations shall be prepared as part of the work plan. This plan should include as many of the cultural and natural features as practical.

2.2 REVIEW BACKGROUND INFORMATION

A search of existing plan files to review the as-built plans is necessary to identify the known location of utilities at the site. Copies of as-built plans shall be copied and maintained for project use. If necessary, the locations of utilities identified shall be plotted onto a preliminary, scaled site plan. Personnel reviewing these files shall inform the Project Manager (PM) if utilities lie within close proximity to a proposed exploration or excavation location. The PM will determine if it is necessary to relocate proposed sampling or excavation locations.

For removal or remedial actions, the utility location information gathered during investigation (e.g., remedial investigation or remedial site evaluation) work shall be included in the project design documents.

It may be necessary to conduct interviews with onsite and facility personnel familiar with the site in order to obtain information regarding the known and suspected locations of underground utilities. The local 1-800-“Before-U-Dig” service must be contacted a minimum of two business days prior to intrusive work. Other appropriate utility or locating companies should be contacted. The dimensions, orientation, and depth of utilities other than those identified on the as-built plans should be penciled in at their

approximate locations on the preliminary plans. The type of utility, the personnel who provided the information, and the date the information was provided should be entered into the field log.

2.3 SITE VISIT - LOCATE UTILITIES - TONING

Prior to the initiation of field activities, a qualified staff member shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depressions. All areas where subsurface exploration is proposed shall be accurately located or surveyed and clearly marked with stakes, pins, flags, paint, or other suitable devices.

Local private utility contractors, familiar with individual base operations and procedures should be subcontracted to identify utilities not located by the "Before U Dig" service. The private locator may be utilized earlier in the project to conduct map research if they are familiar with the base operations. The locator should utilize appropriate sensing equipment to attempt to locate any utilities that may not have appeared on the as-built plans. This may involve the use of surface geophysical methods. At a minimum, a utility locator, metal detector, and/or magnetometer should be utilized; however, it is important to consider the possibility that non-metallic utilities or tanks may be present at the site. If non-metallic cultural features are likely to be present at the site, other appropriate surface geophysical methods, such as Ground Penetrating Radar, should be used. Proposed exploration areas shall be cleared of all utilities in the immediate area where subsurface exploration is proposed. All anomalous areas should be clearly toned.

Any anomalous areas detected and toned that are in close proximity to the exploration or excavation areas shall be reported to the field lead. The field lead shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate proposed exploration or excavation areas. If this is required, the field lead or a similarly qualified individual shall relocate them and clearly mark them using the methods described above. The markings at the prior location shall be completely removed. In some instances, such as in areas extremely congested with subsurface utilities, it is strongly recommended to dig by hand to determine the location of the utilities.

2.4 PREPARE SITE PLAN

Prior to the initiation of some field activities, notably remedial action projects, a final site plan shall be drafted which indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Copies of this site plan shall be provided to the Field Lead, the PM and the subcontractor who is to conduct the subsurface exploration/excavation work. The site plan should be reviewed with the United States Army Corps of Engineers (USACE) PM to verify its accuracy prior to initiating subsurface sampling activities.

3.0 DOCUMENTATION

An approved field logbook detailing the pertinent activities conducted during the utility locating procedure shall be kept. The logbook will describe any changes and modifications made to the original exploration plan. Details of the appropriate procedures for maintaining a logbook are documented in SOP L.

HEADSPACE ANALYSIS

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for performing headspace analysis of soil samples. The SOP will provide descriptions of equipment and procedures for field screening of soil samples. This procedure provides real-time data for soil removal operations, where decisions regarding the extent of soil drilling, excavation, trenching, and disposal must be determined on site. Using this method, the number of soil samples that are to be submitted to a commercial laboratory may be reduced.

2.0 PROCEDURES

2.1 EQUIPMENT

The following equipment is required for headspace analysis:

- Clean glass sample containers
- Zip-lock plastic bags
- Paper towels
- Organic vapor analyzer equipped with a photoionization detector (PID)
- Field notebook
- Equipment Calibration Log
- Appropriate PPE and Health and Safety Plan

2.2 COLLECTION METHOD

Follow the procedures below for the proper collection of headspace analysis:

1. Collect soil sample using a split-spoon sampler, hand auger, or other apparatus, which will yield a soil core or intact sample.
2. Transfer approximately 100 cubic centimeters of sample to a sealable plastic bag or fill the glass container half full.
3. Agitate the sample in the bag or container in order to break up the soil matrix and maximize the surface area of soil that is in contact with the headspace. Allow the sample to equilibrate with the headspace for 15 to 30 minutes. Attempt to keep the samples between 50ºF and 80ºF.
4. Insert the instrument probe inside the bag or container.

5. Read the concentration of the organic vapors after a pre-determined equilibration period has elapsed (approximately 10 to 20 seconds) or after the instrument read-out has stabilized.

6. Record the organic vapor concentration and the gross physical characteristics of the sample (e.g., dry, wet, sandy, discolored).

2.3 ORGANIC VAPOR ANALYZER SELECTION

The selection of the appropriate organic vapor analyzer equipped with either a photo ionization detector (PID) or a flame ionization detector (FID) shall be based on the contaminants of concern and/or ambient conditions at the respective site. The lamp selected for the PID, where applicable, will be based on the relative ionization potentials of the expected volatile contaminants.

2.4 CALIBRATION

The instrument(s) selected for use in accordance with data quality objectives and site requirements shall be calibrated according to the manufacturer's recommendations and specifications. Calibration information shall be recorded on the equipment calibration log and in the field notebook, see Documentation, Section 3.0.

3.0 DOCUMENTATION

All procedures and field conditions shall be recorded in the field logbook. The record shall include a description of the material being screened as well as site conditions such as humidity and the equilibration time and temperature.

The following records will be made in the field logbook:

- Date
- Time
- Personnel
- Weather
- Deviation from this SOP
- Readings collected
- Containers used
- Equipment used
- Calibration performed
- Matrix description

All entries in the field logbook must be printed in black ink and legible.

MONITORING WELL AND PIEZOMETER INSTALLATION

1.0 PROCEDURES

1.1 EQUIPMENT

The following is an equipment list:

- Drill rig capable of installing wells to the desired depth in the expected formation material and conditions
- Well casing and well screen
- Bentonite pellets
- Filter pack sand
- Bentonite Grout or Portland Type I or II cement and powdered bentonite for grouting
- Protective well casing with locking cap
- High-pressure steamer/cleaner
- Long-handled polyethylene or PVC scrub brushes
- Wash/rinse tubs
- Appropriate decontamination supplies as specified in the SOP for decontamination procedures
- Location map
- Polyethylene (e.g., Ziploc) plastic bags (re-sealable)
- Self-adhesive labels
- Weighted tape measure
- Water level probe
- Deionized water
- Logbook
- Boring log sheets

- Well construction form
- Plastic sheeting
- Drums for containment of cuttings and decontamination and/or development water (if necessary)

1.2 DECONTAMINATION

Before drilling or well installation begins, all drilling and well installation material should be decontaminated according to the protocols in SOP M. Drilling equipment should be decontaminated between well locations.

1.3 INSTRUMENT CALIBRATION

Before going into the field, the sampler should verify that field instruments are operating properly. Calibration times and readings should be recorded in a notebook to be kept by the field sampler. Specific instructions for calibrating the instruments are provided in the respective SOPs.

1.4 DRILLING AND WELL INSTALLATION PROCEDURES

1.4.1 Drilling Technique

If soil sampling is required by project plans, all soil samples should be collected according to the subsurface soil sampling procedures. The hole should be logged according to the methods specified in the project plans.

Boreholes should be advanced via sonic drilling methods and a drill rig capable of completing the monitor well(s) to the depth(s) specified in the project plans. Before drilling begins, well locations should be numbered and staked. The necessary permits and utility clearances shall be obtained in accordance with permits and utility clearance procedures.

During the drilling operation, the cuttings from the boring shall be placed into 55-gallon drums or roll-off container as specified in the project plans. Disposal of cuttings should be in accordance with the project plans and follow the procedures of SOP J for investigation-derived waste (IDW) management procedures.

1.4.2 Well Bore Drilling Operations

The procedure for well bore drilling is as follows:

- Set up drilling rig at previously staked and borehole location cleared for utilities.
- Record location, date, time, and other pertinent information in the field logbook.
- Drill hole of appropriate size using the project specified drilling method.
- Collect split-spoon samples at the predetermined intervals, if appropriate, for sample description and/or chemical analysis as specified in the project plans.
- Complete the borehole to the depth specified in the project plans.

- Document any difficult drilling conditions and ensures taken in response to such conditions (such as the addition of clean water to control heave).

1.4.3 Well Design Specifications

The general specifications for wells are as follows:

Boring Diameter. The boring should be of sufficient diameter to permit at least 2 inches of annular space between the boring wall and all sides of the centered riser and screen. The boring diameter should be of sufficient size to allow for the accurate placement of the screen, riser, filter pack, seal, and grout.

Well Casing. The well riser should consist of new, flush-threaded, PVC or stainless steel. The well diameter and thickness should be specified in the project plans. The risers should extend approximately 2 feet above the ground surface, except in the case of flush-mount surface casings. The tops of all well casings should be fitted with plugs or caps in locking monuments and locking caps in non-locking monuments.

Well Screens. The screen length for each well should be specified in the project plans. Well screens should consist of new threaded pipe with factory-machine slots or wrapped screen with an inside diameter equal to or greater than that of the well casing. The slot size should be indicated in the project plans and designed to be compatible with aquifer and sand pack material. The schedule thickness of PVC screen should be the same as that of the well casing. All screen bottoms should be fitted with a cap or plug of the same composition as the screen and should be within 0.5 foot of the open part of the screen. Traps may be used.

1.4.4 Well Installation Procedure

The following procedure should be initiated within 12 hours of well bore completion for uncased holes or partially cased holes and within 48 hours for fully cased holes. Once installation has begun, if no unusual conditions are encountered, there should be no breaks in the installation procedure until the well has been completed and the drill casing has been removed.

The procedure for monitoring well installation is as described below.

1. Decontaminate all well materials according to the SOP for decontamination procedures. After decontamination, all personnel who handle the casing should put on a clean pair of powderless nitrile gloves.

2. Measure each section of casing and screen to nearest 0.10 foot.

3. Assemble screen and casing as it is lowered into the open boring or drill casing.

4. Lower screen and casing to about 6 inches above the bottom of the boring.

5. Record the level of top of casing and calculate the screened interval. Adjust screen interval by raising assembly to desired interval, if necessary, and add selected filter sand to raise the bottom of the boring.

6. Begin adding filter pack sand around the annulus of the screen and casing a few feet at a time while withdrawing the drill casing. Repeated depth soundings should be taken to monitor the level of the sand.

7. Allow sufficient time for the filter sand to settle through the water column outside the casing before measuring the sand level.

8. Extend the filter pack sand to at least 2 to 5 feet above the top of the well screen.

9. After placing the sand filter pack, install a seal at least 3 to 5 feet thick of bentonite pellets or chips. Add the bentonite pellets or chips slowly through the drill casing to avoid bridging. The thickness of the completed bentonite seal should be measured before the pellets have been allowed to swell. The completed bentonite seal should be allowed to hydrate before proceeding with the grouting operations.

10. Grout the remaining annulus from the top of the bentonite seal to near the ground surface as measured after the drill casing has been removed. The grout should be tremied into the borehole until the annulus is completely filled. The base of the tremie pipe should be placed approximately 5 feet above the bentonite seal. Bentonite chips or pellets may be used to backfill the well borehole.

11. After the grout sets for 24 hours it should be checked for settlement. If necessary, additional grout should be added to top off the annulus. This procedure may not be an option in high traffic or unsecured areas.

12. The steel monument, concrete pad and bollards, if required, should be installed according to the specifications in this SOP. The protective casing and posts should be painted a highly visible color.

13. Optional: Personnel should affix to the outer steel protective casing of each well a permanent, noncorrosive tag that clearly identifies the well number, the client's name, or the adjusted top of casing elevation. A well identification tag with a unique Washington State Department of Ecology Well ID must be affixed to the monument.

1.4.5 Well Installation Specifications

Filter Pack. The annular space around the well screen should be backfilled with clean, washed silica sand sized to perform as a filter between the formation material and the well screen. The filter pack should extend a minimum 3 feet above the screen and may be tremied into place. The final depth to the top of the filter pack should be measured directly with the use of a weighted tape measure or rod and not by volumetric calculation methods. The grain size of the filter pack should be shown on the well construction log. The filter pack must be selected based on the grain size distribution of the native formation, and should be specified in the project plans.

Bentonite Seal and Grout. A minimum 2-foot-thick bentonite pellet/chip seal should be placed in the annulus above the filter pack. The thickness of the seal may vary slightly based on site conditions. The thickness of the seal should be measured immediately after placement, without allowance for swelling.

Bentonite Grout or cement grout should then be placed from the top of the bentonite seal to the ground surface. Bentonite grout is preferred because of potential investigation derived waste issues if too much cement grout is prepared and due to heat generated from cement grout. Bentonite grout shall be "high solids" and prepared in accordance with the manufacturer's instructions. Cement grout should consist of a mixture of Portland cement (ASTM C150) and clean water, with a ratio of no more than 7 gallons of clean water per bag of cement (1 cubic foot or 94 pounds). Additionally, 3 percent by weight of bentonite powder should be added if permitted by state regulations. The grout should be prepared in a rigid aboveground container by first thoroughly mixing the cement with water, and then mixing in the bentonite powder. Grout mixtures should be placed, by pumping through a tremie pipe. The lower end of the tremie pipe should be kept within 5 feet of the top of the bentonite seal. Grout should be pumped through the tremie pipe until undiluted grout flows from the annular space at the ground surface. The tremie pipe should then be removed and more grout added to compensate for settling. After 24 hours, the drilling contractor should check the site for grout settlement and add more grout to fill any depression. This should be repeated until firm grout remains at the surface.

Protection of Well. Personnel should at all times during the progress of the work take precautions to prevent tampering with the wells or the entry of foreign material into them. Upon completion of a well, a suitable cap should be installed to prevent foreign material from entering the well. The wells should be enclosed in a protective steel casing. Steel casings should be, at a minimum, 6 inches in diameter and should be provided with locking caps and locks. All locks used at a site should be keyed alike. If the well is to be a stickup (i.e., an aboveground monument), as specified in the project plans, a 1/4-inch drainage hole should be drilled in the protective steel casing, centered approximately 1/8-inch above the internal mortar collar for drainage. The well designation should be painted on the protective casing with a brush or paint pen. Painting should be done prior to well development. If specified in the project plans, a concrete pad should be constructed around the protective casing at the final ground level elevation and sloping away from the well. The concrete pad should measure at least 2 by 2 feet, with a thickness of 6 to 8 inches. Three 3-inch-diameter or larger steel posts should be equally spaced around the well and embedded in separate concrete-filled holes just outside the concrete pad. The protective steel posts should extend approximately 1 foot above the well riser. Any well that is to be temporarily removed from service or left incomplete due to a delay in construction should be capped with a watertight cap and equipped with a "vandal-proof" cover, satisfying applicable state or local regulations or recommendations.

2.0 DOCUMENTATION

Observations and data acquired in the field during the drilling and installation of wells should be recorded to establish a permanent record. A boring log should be completed for each well bore.

Additional documentation of well construction in the field logbook will include the following:

- Top of Casing surveyed elevation to 0.01 feet relative to known benchmarks, control points, and coordinate systems
- Date
- Time

- Personnel
- Weather
- Subcontractors
- Health and safety monitoring equipment and readings
- Description of well location and triangulation measurements from landmarks, or GPS readings.
- Quantity and composition of grout, seals, and filter pack actually used during construction
- Screen slot size (in inches), slot configuration, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer
- Coupling/joint design and composition
- Protective casing composition and nominal inside diameter
- Start and completion dates
- Discussion of all procedures and any problems encountered during drilling and well construction

In addition, the well installation details should be shown in a diagram drawn in the field logbook. Each well diagram should consist of the following (denoted in order of decreasing depth from the ground surface):

- Reference elevation for all depth measurements
- Project and site names
- Well number
- Date(s) of installation
- Depth at which the hole diameter changes (if appropriate)
- Depth of the static water level and date of measurement(s)
- Total depth of completed well
- Depth of any grouting or sealing
- Nominal hole diameter(s)
- Depth and type of well casing
- Description (to include length, internal diameter, slot size, and well screen material
- Any sealing off of water-bearing strata

- Static water level upon completion of the well and after development
- Drilling date(s)
- Other construction details of monitoring well including grain size of well filter pack material and location of all seals and casing joints

All entries in the field logbook should be printed in black ink and legible.

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MONITORING WELL DEVELOPMENT

1.0 PROCEDURE

1.1 INTRODUCTION

Well development procedures are crucial in preparing a well for sampling. Development enhances the flow of groundwater from the formation into the well and grades the well filter pack to reduce the movement of fine (clay and silt) particles into the well. The reduction in groundwater sample turbidity achieved by development improves the representation of chemical analyses performed on groundwater samples.

The goal of well development is to restore the area adjacent to a well to its natural condition by correcting damage to the formation during the drilling process. Well development should accomplish the following tasks:

- Remove any filter cake or any drilling fluid within the borehole that affects formation permeability.
- Grade the well filter pack to reduce the intrusion of fine formation particles.

Well development should not be performed sooner than 24 hours after the completion of well installation to allow the annular seal to fully set up.

1.2 FACTORS AFFECTING MONITORING WELL DEVELOPMENT

1.2.1 Type of Geologic Materials

Different types of geologic materials are developed more effectively by using certain development methods. Where permeability is greater, water moves more easily into and out of the formation and development is accomplished more quickly. Highly stratified deposits are effectively developed by methods that concentrate on distinct portions of the formation. If development is performed unevenly, a ground-water sample will likely be more representative of the permeable zones. In uniform deposits, development methods that apply powerful surging forces over the entire screened interval will produce satisfactory results.

1.2.2 Design and Completion of the Well

Because the filter pack reduces the amount of energy reaching the borehole wall, it must be as thin as possible if the development procedures are to be effective in removing fine particulate material from the interface between the filter pack and natural formation. Conversely, the filter pack must be thick enough to ensure a good distribution of the filter-pack material during emplacement and allow effective grading during development. Generally, filter pack material must be at least 2 inches thick. Variances from state agencies may be required for filter pack materials of less than 2 inches thick.

The screen slot size must be appropriate for the geologic material and filter pack material in order for development to be effective. If the slot size is too large, the filter pack and native material will enter the well, causing settlement of overlying materials and sediment accumulation in the casing. If the slot size is too small, full development may not be possible and the well yield will be below the potential of the formation. Additionally, incomplete development coupled with a narrow slot size can lead to blockage of the screen openings.

1.2.3 Drilling Method

The drilling method influences development procedure. Typical problems associated with specific drilling methods include the following:

- If a mud rotary method is used, a mudcake builds up on the borehole wall and must be removed during the development process.
- If drilling fluid additives have been used, the development process must attempt to remove all fluids that have infiltrated into the native formation.
- If driven casing or hollow-stem auger methods have been used, the interface between the casing or auger flights and the natural formation may have been smeared with fine particulate matter that must be removed during the development process.
- If an air rotary method has been used in rock formations, fine particulate matter is likely to build up on the borehole walls and may plug pore spaces, bedding planes, and other permeable zones. These openings must be restored during the development process.

1.3 PREPARATION

In preparing for monitoring well development, development logs for any other monitoring wells in the vicinity should be reviewed to determine the general permeability of the water-bearing formation, the associated likely groundwater yield from the well and the appropriate development method.

Depth to groundwater and information from the well construction log should be used in calculating of the required quantity of water to be removed. The distance between the equilibrated water level and the bottom of screen is the saturated section. The saturated section (feet) multiplied by the unit well volume per foot (gallons/linear foot) equals the gallons required to remove one total well volume of water. The unit well volume is the sum of the casing volume and the filter-pack pore volume, both of which depend upon casing and borehole diameter and the porosity of the filter pack material. Well volume for wells can be calculated using tables below:

Casing Volume

Casing Diameter (inches)	Volume (gallon/linear foot)
2	0.16
4	0.65
6	1.47

Filter Pack Pore Volume

Casing Diameter (inches)	Borehole Diameter (inches)	Volume[a] (gallon/linear foot)
2	6	0.52
2	8	0.98
4	10	1.37
4	12	2.09
6	12	1.76

* The above two volumes must be added together to obtain one unit well volume.

[a] Assumes a porosity of 40% for filter pack.

1.4 DECONTAMINATION

The purpose of decontamination of development equipment is to prevent cross-contamination between monitoring wells. A steam-cleaner, if available, should be used to decontaminate development equipment. The equipment should be cleaned away from the monitoring well in such a fashion that decontamination effluent can be containerized.

A triple rinse decontamination procedure is acceptable for equipment such as bailers if access to a steam cleaner is not possible. See SOP - M.

1.5 WELL DEVELOPMENT MONITORING

Throughout the well development process, a development record should be maintained in the field logbook. The record should include the following information:

General

- Well name/number and location
- Date, time, and weather conditions
- Names of personnel involved

Development volume

- Initial and final water level
- Casing total depth and diameter
- Borehole diameter
- Casing volume, filter pack pore volume, total well volume
- Volume of water to be evacuated
- Method and rate of removal
- Appearance of water before and after development

Monitoring data for each sample point

- Date, time, elapsed time
- Cumulative gallons removed, removal method, removal rate
- Temperature, pH, specific conductance, turbidity, dissolved oxygen, and redox potential

Part of the well development procedure should consist of acquisition and analysis of general water quality parameters at periodic intervals, considering the total quantity of water to be removed and the removal rate. Depending on site conditions, the parameters specific conductance, pH, temperature, dissolved oxygen, turbidity, and redox potential may be measured. At a minimum the temperature, pH and turbidity should be monitored. Parameter measurements should be collected on a periodic basis during development. At a minimum, these parameters should be measured after removal of each well volume. The cumulative water volume of removed, the clock time, and the time elapsed during development should be recorded and a flow rate should be calculated. Development should continue until turbidity stabilizes at or below 10 nephelometric units or at least three well volumes have been removed. If three successive parameter measurements show stable values (values within 10% of each other) and turbidity is low, well development may cease. If stabilization has not been attained, if turbidity remains high, or if the well does not readily yield water, development should continue for a reasonable time as determined in the project plans or by the Project Manager.

The discussion of well development in special situations such as low yield formations is described in Section 1.7.

1.6 METHODS OF MONITORING WELL DEVELOPMENT

The methods available for the development of monitoring wells have been inherited from production well practices. Methods include (1) mechanical surging with a heavy, non-disposable bailer (stainless steel or PVC) surge block or swab, and (2) surge pumping. Development methods using air or jetting of water into the well are discouraged because of the potential for affecting water quality. In some circumstances, air or water jet development may be necessary and should be conducted under the supervision of a qualified hydrogeologist.

All development water must be containerized and appropriately labeled, unless it is permissible to discharge onsite. Development should generally utilize mechanical surging or surge pumping, followed by bailing or groundwater removal with a pump. More detailed descriptions of appropriate development methods are presented below.

1.6.1 Mechanical Surging and Bailing

For mechanical surging and bailing, a heavy bailer, surge block or swab is operated either manually or by a drill rig. The bailer, surge block, or swab should be of sufficient weight to free-fall through the water in the well and create a vigorous outward surge. The equipment lifting the tool must be strong enough to extract it rapidly. A bailer is then used to remove fine-grained sediment and groundwater from the well.

Methodologies:

1. Properly decontaminate all equipment entering well.
2. Record the static water level and the total well depth.
3. Lower the bailer, surge block or swab to top of the screened interval.
4. Operate in a pumping action with a typical stroke of approximately 3 feet.
5. Gradually work the surging downward through the screened interval during each cycle.
6. Surge for several minutes per cycle.
7. Remove surge block and attach bailer in its place.
8. Bail to remove fines loosened by surging until water appears clear.
9. Repeat the cycle of surging and bailing until turbidity is reduced and stabilization of water quality parameters occurs.
10. The surging should initially be gentle and the energy of the action should gradually increase during the development process.

The advantages (+) and disadvantages (–) of this method are listed below:

+ It reverses the direction of flow, reduces bridging between large particles; the inflow then moves the fine material into the well for withdrawal.

+ It affects the entire screened interval.

+ It effectively removes fines from the formation and the filter pack.

– It may cause upward movement of water in the filter pack that could disrupt the seal.

– Potential exists for damaging a screen with a tight-fitting surge block or with long surge strokes.

1.6.2 Surge Pumping

Methodologies:

1. Properly decontaminate all equipment entering well.
2. Record the static water level and the total well depth.
3. Lower a submersible pump or airlift pump without a check valve to a depth within 1 to 2 feet of the bottom of the screened section.
4. Start pumping and increase discharge rate causing rapid drawdown of water in the well.
5. Periodically stop and start pump, allowing the water in the drop pipe to fall back into the well and surge the formation (backwashing), thus loosening particulates.
6. The pump intake should be moved up the screened interval in increments appropriate to the total screen length.
7. At each pump position, the well should be pumped, over-pumped, and backwashed alternately until satisfactory development has been attained as demonstrated by reduction in turbidity and stabilization of water quality parameters.

The advantages (+) and disadvantages (–) of this method are listed below:

+ Reversing the direction of flow reduces bridging between large particles, and the inflow then moves the fine material into the well for withdrawal.

+ It effectively removes fines from the formation and filter pack.

– The pump position or suction line must be changed to cover the entire screen length.

– Submersible pumps suitable to perform these operations may not be available for small diameter (2 inches or less) monitoring wells.

– It is not possible to remove sediment from the well unless particle size is small enough to move through pump.

For additional information on well development, consult the references included in Section 3.0 of this SOP.

1.7 SPECIAL SITUATIONS

1.7.1 Development of Low Yield Wells

Development procedures for monitoring wells in low-yield (<0.25 gpm) water-bearing zones are somewhat limited. Due to the low hydraulic conductivity of the materials, surging of water in and out of the well casing is difficult. Also, when the well is pumped, the entry rate of water is inadequate to remove fines from the well bore and the gravel pack. Additionally, the process may be lengthy because the well can be easily pumped dry and the water level will be very slow to recover.

The procedures for mechanical surging and bailing should be followed for low yield wells. During surging and bailing, wells in low yield formations should be drawn down to total depth twice if possible. Development can be terminated, however, if the well does not exhibit 80% recovery after 2 hours have passed.

2.0 DOCUMENTATION

Well development information should be documented in field logbooks in accordance with SOP L using indelible ink. In addition, well development monitoring forms may be filled out in addition to the field logbook documentation. Copies of this information should be sent to the Project Manager and to the project files.

3.0 REFERENCES

Driscoll, F.G. 1987. Ground Water and Wells. Published by Johnson Division, St. Paul, Minnesota.

USEPA. 1992. RCRA, Ground Water Monitoring Technical Enforcement Guidance Document. U.S. Environmental Protection Agency/530/R-93/001. November.

U.S. EPA Environmental Response Team. 1988. Response Engineering and Analytical Contract Standard Operating Procedures. U.S. EPA, Research Triangle Park, NC.

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IDW MANAGEMENT

1.0 PURPOSE

This standard operating procedure (SOP) describes the activities and responsibilities with regard to management of investigation-derived waste (IDW). The purpose of this procedure provides guidance for the minimization, handling, labeling, temporary storage, and inventory of IDW generated during site investigations and remediation projects. This SOP is also applicable to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste and other regulated wastes generated during implementation of site investigations and removal or remedial actions.

2.0 PROCEDURES

The procedures for IDW management in the field are described below in Sections 2.1 to 2.5. The implementation of these procedures requires Project Managers (PMs), Field Leads, their designates and subcontractors to perform the following tasks:

- Minimize generation of IDW,
- Segregate IDW,
- Properly handle IDW containers,
- Properly label IDW containers,
- Apply good management practices in storing IDW drums and containers,
- Prepare IDW drum inventories,
- Update and Report changes to IDW drum inventories,
- Perform inspections of IDW containers and storage areas, as required,
- Prepare IDW containers for proper off-site transportation and disposition, as required.

2.1 IDW MINIMIZATION

Field Leads and their designates shall minimize the generation of onsite IDW to reduce the need for special storage or disposal requirements that may result in substantial additional costs and provide little or no reduction in site risks (EPA 1992). The volume of IDW shall be reduced, by applying minimization practices throughout the course of site investigation activities. These minimization

strategies include: 1) material substitution; 2) using proper low-volume drilling techniques (e.g. sonic); 3) using disposable sampling and PPE; 4) using bucket and drum liners; and 5) segregating non-contaminated IDW and trash from contaminated IDW. Waste minimization strategies and types of IDW expected to be generated shall be documented in the appropriate project plans.

2.1.1 Material Substitution

Material substitution consists of selecting materials that degrade readily or have reduced potential for chemical impacts to the site and the environment. An example of this practice is the use of biodegradable detergents (e.g., Alconox® or non-phosphate detergents) for decontamination of non-consumable PPE and sampling equipment. In addition, field equipment decontamination can be conducted using isopropyl alcohol rather than hexane or other solvents (for most analytes of concern), to reduce the potential onsite chemical impacts of the decontamination solvent. Decontamination solvents shall be selected carefully so that solvents, and their known decomposition products, do not result in generation of RCRA hazardous waste.

2.1.2 Decontamination Fluids

The use of disposable sampling equipment, such as plastic bailers, trowels, and drum thieves (which do not require decontamination) minimizes the quantity of decontamination fluids generated. In general, decontamination fluids, and well development and purge water, should not be minimized because the integrity of the associated analytical data may be affected.

2.1.3 PPE and Disposable Sampling Equipment

Visibly soiled PPE and disposable sampling equipment shall be segregated from non-visibly soiled PPE and sampling equipment. Where investigation involves potentially hazardous waste or other regulated wastes, visibly soiled PPE and disposable sampling equipment may require decontamination. The Field Lead shall use best professional judgment to determine if decontamination is appropriate. This determination should be included in the approved QAPP. If decontamination is performed, PPE and disposable sampling equipment generated in the decontamination process may be double-bagged and disposed of as non-hazardous waste.

2.1.4 Liners

Bucket liners can be used in the decontamination process to reduce the volume of solid IDW-generated and reduce costs on larger projects. The plastic bucket liners can be crushed into a smaller volume than the buckets, and only a small number of plastic decontamination buckets are required for the entire project. Larger, heavy-duty, 55-gallon drum liners can be used for heavily contaminated IDW to provide secondary containment, and reduce the costs of disposal and drum recycling. Drum liners may extend the containment life of the drums in severe climates and will reduce the costs of cleaning out the drums prior to recycling.

2.1.5 Segregation of non-IDW

All waste materials generated in the support zone are considered non-IDW trash. To minimize the total volume of IDW, all trash shall be separated from IDW, sealed in garbage bags, and properly disposed of offsite as municipal waste.

2.1.6 Monitoring Well Construction

Excess cement, sand, and bentonite grout prepared for monitoring well construction shall be kept to a minimum. Well construction shall be observed by Field Leads to ensure that a sufficient, but not excessive, volume of grout is prepared. Some excess grout may be produced. Unused grout that has not come in contact with potentially contaminated soil or ground water shall be considered non-hazardous trash and shall be disposed of offsite by the drilling subcontractor. Surplus materials from monitoring well installation, such as scrap PVC sections, used bentonite buckets, and cement/sand bags that do not come in contact with potentially contaminated soil, shall be considered non-IDW trash and shall be disposed of offsite by the drilling subcontractor.

2.1.7 Field Analytical Test Kits

IDW generated from the use of field analytical test kits consists of those parts of the kit that have been used and/or come into contact with potentially contaminated site media, or excess extracting solvents and other reagents. Potentially contaminated solid test kit IDW shall be contained in plastic bags and stored with PPE or disposable sampling equipment IDW from the same source area as soil material used for the analyses. The small volumes of waste solvents, reagents, and water samples used in field test kits should be segregated, and disposed of accordingly. Most other test kit materials should be considered non-IDW trash, and be disposed of as municipal waste.

2.2 SEGREGATION OF IDW BY MATRIX AND LOCATION

To facilitate subsequent IDW screening, sampling, classification and/or disposal, IDW shall generally be segregated by matrix and source location at the time it is generated. Each drum of solid IDW shall be completely filled, when possible. For liquid IDW, drums should be left with headspace of approximately 5% by volume to allow for expansion of the liquid and potential volatile contaminants. IDW from each distinct matrix shall be stored in a single drum (e.g., soil, water or PPE shall not be mixed in one drum). In general, IDW from separate sources should not be combined in a single drum.

It is possible that monitoring well development and purge water will contain suspended solids, which will settle to the bottom of the storage drum as sediment. Significant observations on the turbidity or sediment load of the development or purge water shall be included in the logbook and reported in attachments to the quarterly drum inventory report (see SOP - L and Section 2.5). To avoid having mixed matrices in a single drum (i.e., sediment and water), it may be necessary to decant the liquids into a separate drum, after the sediments have settled out. This segregation may be accomplished during subsequent IDW sampling activities or during consolidation in a holding tank prior to disposal. Appropriate precautions per the approved Accident Prevention Plan Plan (APP) shall be implemented to ensure worker protection during these activities.

Potentially contaminated well construction material shall be placed in separate containers. Soil, sediment, sludge, or liquid IDW shall be segregated from potentially contaminated waste well construction materials. Potentially contaminated well construction materials from different monitoring wells shall not be commingled.

Potentially hazardous PPE and disposable sampling equipment shall be segregated from other IDW. PPE from generally clean field activities, such as water sampling, shall be segregated from visibly soiled PPE, double-bagged and disposed of offsite as municipal waste. Disposable sampling equipment from activities such as soil, sediment, and sludge sampling includes plastic sheeting used as liner material in containment areas around drilling rigs and waste storage areas; disposable sampling equipment; and soiled decontamination equipment. Where investigation involves potentially hazardous waste, visibly soiled PPE and disposable sampling equipment may require decontamination. The Field Lead shall use best professional judgment to determine if decontamination is appropriate. If decontamination is performed, PPE and disposable sampling equipment generated in the decontamination process may be double-bagged and disposed of as non-hazardous waste. PPE and disposable sampling equipment generated on separate days may be commingled.

Decontamination fluids shall be stored in drums separate from other IDW. If practical, decontamination fluids generated from different sources should not be stored in the same drum. If decontamination fluids generated over several days or from different sources are stored in a single container, information regarding dates of generation and sources shall be recorded in the field notebook, on the drum label (Section 2.3.2), and in the drum inventory (Section 2.5).

Liquid and sediment portions of the equipment decontamination fluid in the containment unit used by the drilling or excavation field crew should be separated. The contents of this unit normally consist of turbid decontamination fluid above a layer of predominantly coarse-grained sediment. When the contents of the containment unit are to be stored in IDW containers, the Field Lead shall direct the placement of as much liquid into drums as possible and transfer the remaining solids into separate drums. Observations of the turbidity and sediment load of the liquid IDW should be noted in the field notebook, on the drum label (Section 2.3.2), and in attachments to the drum inventory (see Section 2.5). It is likely that decontamination fluids will contain minor amounts of suspended solids that will settle out of suspension to become sediment at the bottom of IDW storage drums. As noted above, it may be necessary to segregate the drummed water from sediment during subsequent IDW sampling or disposal activities.

2.3 DRUM HANDLING AND LABELING

Drum handling consists of those actions necessary to prepare an IDW drum for labeling. Drum labeling consists of those actions required to legibly and permanently identify the contents of an IDW drum. Specific handling, storage, and labeling requirements may differ with the Naval installation or oversight entity. Specific requirements should be determined at the planning stage and documented in the QAPP. General requirements are provided in the following sections.

2.3.1 Drum Handling

The drums used for containing IDW shall be approved by the United States Department of Transportation (DOT, 49 CFR 172). The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., 1A1 or 1A2). New steel drums are preferred over recycled drums. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. Consideration must be given to scheduling and cost-effectiveness of bulk storage, treatment, and discharge system versus longer-term drum storage.

For long-term IDW storage, the DOT-approved drums with removable lids are recommended. The integrity of the foam or rubber sealing ring located on the underside of some drum lids shall be verified prior to sealing drums containing IDW liquids. If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, a drum lid with sealing ring that is in good condition must be used. At some facilities, drums containing liquid IDW will be required to be stored in protective overpacks.

To prepare IDW drums for labeling, the outer wall surfaces and drum lids shall be wiped clean of all material that may prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, that material shall be wiped from the drum, and the paper towel or rag used to remove the material shall be segregated with visibly soiled PPE and disposable sampling equipment.

2.3.2 Drum Labeling

Proper labeling of IDW drums is essential to the success and cost-effectiveness of subsequent waste screening and disposal activities. Labels shall be permanent and descriptive to facilitate correlation of field analytical data with the contents of individual IDW drums.

2.3.2.1 Preprinted Labels

A preprinted drum label as required by the appropriate regulatory agency shall be completed. The label will be affixed to the outside of the drum (or overpack if required) with the label easily readable for inspections and inventory. Label requirements may vary based on the site. The requested information shall be printed legibly on the drum labels in black, indelible ink.

Painted Labels

An alternative method for labeling drums, if acceptable for the project, is to paint label information directly on the outer surface of the drum. At a minimum, the information placed on the drum shall include the contract/delivery order number, a drum number, the source identification type and number, the type of IDW, the generation date(s), and the government point of contact and telephone number. The drum surface shall be dry and free of material that could prevent legible labeling. Label information shall be confined to the upper two-thirds of the total drum height. The printing on the drum shall be large enough to be easily legible. Yellow, white, or red paint markers (oil-based enamel paint) that are non-photodegradable are recommended to provide maximum durability and contrast with the drum surface.

2.3.2.2 Regulatory Marking and Labeling

Federal and State regulations may require specific labeling for IDW generated (i.e., RCRA, TSCA, NESHAPs). Pre-printed labels shall be used as appropriate and completed in accordance with the specific regulatory requirement. These requirements will be identified in the approved project plans. Once determined to be hazardous, weekly inspections must also be conducted to ensure that labels and markings are in good conditions and to ensure the integrity of containers.

In addition, prior to off-site transportation USDOT requirements for marking and labeling of regulated DOT materials must be complied with. These requirements will be identified in the approved project plans or otherwise coordinated with the Field Lead after the IDW has been characterized and off-site disposition is being planned. Note that personnel (i.e., contractors or subcontractors) who perform USDOT functions must be properly trained in accordance with 49 CFR 172, Subpart G.

2.4 DRUM STORAGE

Drum storage procedures shall be implemented to minimize potential human contact with the stored IDW and prevent extreme weathering of the stored drums. Waste accumulation areas will be pre-designated prior to the start of site work. IDW drums should be placed on pallets. Good management practices should be used in storing drums which include: containers shall be in good condition and closed during storage; wastes must be compatible with containers; where liquids are stored, storage areas should have secondary containment; and spill or leaks should be removed as soon as possible. These good management practices are mandatory requirements where RCRA hazardous wastes are stored.

Waste accumulation areas shall be maintained as prescribed by local regulatory entities. In general, drums of IDW shall be stored within the Area of Concern (AOC) so that the site can utilize RCRA regulatory flexibility (i.e., administrative requirements, such as 90-day storage, may not be triggered). If IDW is determined to be RCRA hazardous waste, then RCRA storage, transportation and disposal requirements must be met.

Drums shall be stored at identified waste accumulation areas. All IDW drums generated during field activities at a single AOC shall be placed together, in a secure, fenced onsite area to prevent access to the drums by unauthorized personnel. When a secure area is not available, drums shall be placed in an area of the site with the least volume of human traffic. Plastic sheeting (or individual drum covers) and yellow caution tape shall be placed around the stored drums. Drums from projects involving multiple AOCs should remain at the respective source areas where the IDW was generated. IDW should not be transferred offsite for storage elsewhere, except under rare circumstances, such as the lack of a secure storage area onsite.

Proper drum storage practices shall be implemented to minimize damage to the drums from weathering and possible exposure to humans or the environment. When possible, drums shall be stored in dry, shaded areas and covered with impervious plastic sheeting or tarpaulin material. Every effort shall be made to protect the preprinted drum labels from direct exposure to sunlight, which causes ink on the labels to fade. In addition, drums shall be stored in areas that are not prone to flooding. The impervious drum covers shall be appropriately secured to prevent dislodging by the wind. It may be possible to

obtain impervious plastic covers designed to fit over individual drums; however, the labeling information shall be repeated on the outside of these opaque covers.

Drums in storage shall be placed with sufficient space between rows of drum pallets and shall not be stacked, such that authorized personnel may access all drums for inspection. Proper placement will also render subsequent IDW screening, sampling, and disposal more efficient. It is recommended that IDW drums be segregated in separate rows/areas by matrix (i.e., soil, liquid or PPE/other).

If repeated visits are made to the project site, the IDW drums shall be inspected to clear encroaching vegetation, check the condition and integrity of each drum, check and replace labels as necessary, and replace or restore protective covers.

2.5 DRUM INVENTORY

Accurate preparation of an IDW drum inventory is essential to all subsequent activities associated with IDW drum tracking and disposal. An inventory shall be prepared for each project in which IDW is generated, stored, and disposed of. Local regulatory authorities may have specific requirements associated with waste inventory and these requirements should be included in the planning process and documented in the QAPP.

The drum inventory information shall include 11 elements that identify drum contents and indicate their fate.

2.5.1 Generator/Site Name

Inventory data shall include the activity and the site name where the IDW was generated.

2.5.2 Project Number

Inventory data shall include the contract and delivery order number associated with each drum (e.g., 0089).

2.5.3 Drum Number

The drum number assigned to each drum shall be included in the inventory database.

2.5.4 Storage Location Prior to Disposal

The storage location of each drum prior to disposal shall be included in the inventory.

2.5.5 Origin of Contents

The source identification of the contents of each IDW drum shall be specified in the inventory (e.g., well number).

2.5.6 IDW Type

Inventory data shall include the type of IDW in each drum (e.g., soil, PPE, disposable sampling equipment, development water, steam cleaning water, decontamination rinse water).

2.5.7 Waste Volume

The amount of waste in each drum shall be specified in the inventory as a percentage of the total drum volume or an estimated percentage-filled level (e.g., 95% maximum for liquid IDW).

2.5.8 Recommended Analytical Methods and Test Results Compared with Applicable Regulatory Standards

The recommended EPA analytical methods that adequately characterize IDW contained in each drum will be summarized in a tabular format. The methodology for sampling and characterizing IDW shall be specified in the appropriate project plans.

2.5.9 Generation Date

Inventory data shall include the date IDW was placed in each drum. If a drum contains IDW generated over more than one day, the start date for the period shall be specified in dd-month-yy format. This date is not to be confused with an RCRA hazardous waste accumulation date (40 CFR 262). The accumulation start date, if required for RCRA wastes, shall be included on the hazardous waste drum label (Section 2.3.2.2).

2.5.10 Disposal Date

The actual drum disposal date occurs at the time of onsite disposal, or acceptance by the offsite treatment or disposal facility. It shall only be entered in the drum inventory database when such a date is available in dd-month-yy format.

In order to provide information for all 11 of the inventory elements of the quarterly inventory report described above, the main source of information will be provided by PMs, or their designees.

The recommended analytical test methods and actual test results (compared to applicable regulatory standards) will be provided to the United States Army Corps of Engineers (USACE), by the PM, or their designees, when such data are available. Testing methods shall be documented in the associated project plans. Recommended disposal options or actual disposition of the IDW drum contents will also be provided by PMs as data become available.

3.0 DOCUMENTATION

The PM or designee is responsible for completing and updating the site-specific IDW drum inventory spreadsheet and submitting it as needed. The PM is also responsible for submitting backup documentation to the USACE about the analytical methods recommended to adequately characterize the IDW in each drum (Section 2.5.8). In addition, actual site or drum sampling results shall be forwarded to

the PMO, along with a comparison to the applicable regulatory standards, for inclusion as attachments to the quarterly IDW drum inventory. As necessary, the backup documentation to the quarterly IDW drum inventory report shall also include the recommended means for IDW disposal for each drum (Section **Error! Reference source not found.**). After disposal, the actual means and/or location of disposal shall be indicated in tabular format with supporting narrative.

Field Leads and designates are responsible for documenting all IDW-related field activities in the field notebook, including most elements of the IDW drum inventory spreadsheet. The correct methods for developing and maintaining a field notebook are presented in SOP L.

Upon receipt of analytical data from the investigation, the information will be forwarded to the appropriate USACE authority for comparison to regulatory waste criteria. The USACE will designate the IDW and disposal options will be assessed based on the waste designation, approved transport/disposal facilities, and schedule for disposal. Joint Base Lewis-McChord (JBLM) may have additional requirements for reviewing analytical data, characterizing waste materials, transportation, and off-site disposal. The PM shall coordinate with the USACE early in the planning process to ensure that these requirements are properly identified, incorporated into the approved project plans, as available, and implemented in the field.

The disposal of IDW must be approved by the USACE and, in some cases, pertinent regulatory agencies. The disposal must be documented.

4.0 REFERENCES

Department of Transportation (DOT), Hazardous Materials Transportation Regulations, 49 CFR Parts 171 – 179.

EPA. 1998. EPA530-F-98-026, Management of Remediation Waste Under RCRA

EPA. 1991. Management of Investigative-Derived Wastes During Site Inspections. U.S. Environmental Protection Agency/540/G-91/009. May.

EPA. 1992. Guide to Management of Investigative-Derived Wastes. Quick Reference Guide. U.S. Environmental Protection Agency: 9345.3-03FS. January.

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LAND SURVEYING

1.0 PURPOSE

This standard operating procedure (SOP) sets forth protocols for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.

2.0 PROCEDURES

The procedures listed below shall be followed during land surveying:

- All surveying work shall be performed under the direct supervision of a land surveyor registered in the state or territory in which the work is being performed (i.e. a Professional Land Surveyor, PLS).
- Survey instruments shall be calibrated in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall have been calibrated no more than 6 months prior to the start of the survey work.
- Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration (NOAA) standards and at the minimum accuracy standards set forth below. The horizontal accuracy for location of all grid intersection and planimetric features shall be (±) 0.1 feet. The horizontal accuracy for boundary surveys shall be one in ten thousand feet (1:10,000). The vertical accuracy for ground surface elevations shall be (±) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (±) 0.01 feet.
- Surveys shall be referenced to the local established coordinate systems and all elevations and benchmarks established shall be based on North American Vertical Datum of 1988.
- Surveyed points shall be referenced to Mean Sea Level (Mean Lower Low Water Level).
- Appropriate horizontal and vertical control points shall be jointly determined prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates and elevations. All surveyed locations shall be mapped using a base map or other site mapping specified by the Project Manager.

- All surveys shall begin and end at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.

- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Pins shall be driven to a depth of 18 inches into the soil.

- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. They shall be clearly marked with brightly colored weatherproof flagging and paint.

- The point on a monitoring well casing that is surveyed shall be clearly marked by filing grooves into the casing on either side of the surveyed point.

3.0 DOCUMENTATION

Using generally accepted practices, field notes shall be recorded daily by the surveyor in paper or electronic format. The data shall be neat, legible and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and submitted to the Navy or designee.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey

- General weather conditions

- The name of the surveying firm

- The names and job titles of personnel performing the survey work

- Equipment used, including serial numbers

- Field book designations, including page numbers.

Drawings and calculations submitted by the surveyor shall be signed, sealed and certified by a land surveyor registered (PLS stamped) in the state or territory in which the work was done.

Dated records of land surveying equipment calibration shall be provided by the surveyor along with equipment serial numbers and calibration records.

RECORD KEEPING, SAMPLE LABELING, AND CHAIN-OF-CUSTODY PROCEDURES

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish standard protocols for all field personnel and their contractors for use in maintaining field and sampling activity records, writing sample logs, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.

2.0 PROCEDURES

Standards for documenting field activities, labeling the samples, documenting sample custody, and completing chain-of-custody and analytical request forms are provided in this procedure. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

2.1 RECORD KEEPING AND LOGBOOKS

The field logbook serves as the primary record of field activities. Entries shall be made chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Field logs such as soil boring logs and ground-water sampling logs will also be used. Prior to commencement of field work, logbooks will be assigned to field personnel by the Project Manager. If personnel changes must be made during a project, the successor may use the same logbook. In this case, the logbook cover page will indicate all persons who have made entries and the dates. This may be inappropriate if there are a large number of people involved.

The logbook user is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The logbook user is also responsible for safeguard of the logbook while having custody of it.

Individuals performing specific tasks associated with a field project may keep a separate logbook; however, these logbooks must conform to this procedure and will become a permanent part of the central project file. The Project Manager is responsible for reviewing and signing all field logbooks associated with the project.

The field team provides a permanent record of daily activities, observations, and measurements through the use of a field logbook. All logbook entries will be made in indelible black or blue ink. No erasures are permitted. If an incorrect entry is made, the data will be crossed out with a single line and initialed and dated by the originator. Entries can be organized into easily understood tables if possible.

All logbook pages will be signed and dated at the bottom. Times will be recorded next to each entry. If a full page is not used during the course of a workday, a diagonal line will be drawn through the unused

portion of the page and signed (in this case, it would not be necessary to sign the bottom of the page). If the project is completed and the logbook has not been completely filled, a diagonal line will be drawn across the first blank page after the last entry, and "no further entries" written before the page is signed and dated.

Daily entries will be made during field activities by, at a minimum, one field team member to provide daily records of all significant events, observations, and measurements during field operations. Notes will start at the beginning of the first blank page and extend through as many pages as necessary. All page numbers will be consecutively numbered as the logbook is filled.

The inside cover page of each logbook will contain the following information:

- Book number
- Project name
- Contract number
- Project number
- Project Activity/Installation
- Site name
- Start date
- End date
- Person to whom the logbook is assigned
- Agency/Company name
- Agency/Company address
- Agency/Company phone number

The field logbook serves as the primary record of field activities. When possible, the field book should be dedicated to a singular Project/Installation to facilitate long term records archiving. Entries shall be made chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, names of all samples collected shall be included in the logbook even if recorded elsewhere.

Typical information to be entered includes, but is not limited to, the following:

- Date and time of all onsite activities

- Site location and description
- Weather conditions
- Field work documentation
- Descriptions of and rationale for approved deviations from the QAPP
- Field instrumentation readings
- Personnel present
- Photograph references
- Sample locations
- Sample identifications
- Field QC sample information
- Field descriptions, equipment used, and field activities accomplished to reconstruct field operations
- Meeting information
- Daily health and safety meeting notes
- Important times and dates of telephone conversations, correspondence, or deliverables
- Field calculations
- PPE level
- Calibration records
- Subcontractors present
- Equipment decontamination procedures and effectiveness
- Procedures used for containerization of investigative derived waste

Logbook page numbers shall appear on each page to facilitate identification of photocopies.

If a person's initials are used for identification, or if uncommon acronyms are used, these should be identified on a page at the beginning of the logbook.

At least weekly and preferably daily, the preparer shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

A technical review of each logbook shall be performed by a knowledgeable individual such as the Project Manager.

2.2 SAMPLE LABELING

A sample label with adhesive backing shall be affixed to each individual sample container. Clear tape shall be placed over each label (preferably prior to sampling) to prevent the labels from tearing off, falling off, or being smeared, and to prevent loss of information on the label. Bottles should be pre-labeled outside of the immediate sampling environment using a black ink pen. Pens of any kind are prohibited in the immediate sampling environment. The following information shall be recorded on each label:

- Project name or number (optional)
- Sample ID
- Date and time of collection
- Sampler's initials
- Matrix (optional)
- Sample preservatives (if applicable)
- Analysis to be performed on sample. This shall be identified by the method number or name identified in the subcontract with the laboratory. For water samples, a separate container is typically used for each separate test method, whereas with soil samples, multiple analyses can be performed on the soil obtained from one sample container. In order to avoid lengthy lists on each container and confusion, soil sample containers may not list every analysis to be performed.

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels. The adhesive glue used on the labels must be such that it does not contaminate the sample.

2.3 CUSTODY PROCEDURES

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Custody of samples shall be maintained in accordance with EPA chain-of-custody guidelines as prescribed in EPA's *NEIC Policies and Procedures*, National Enforcement Investigations Center, Denver, Colorado, revised May 1986; EPA *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (TEGD), *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA OSWER Directive 9355 3-01), Appendix 2 of the *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*, and *Test Methods for Evaluating Solid Waste* (EPA SW-846). A description of sample custody procedures is provided below.

2.3.1 Sample Collection Custody Procedures

According to EPA's *NEIC Policies and Procedures*, a sample is considered to be in custody if:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

Custody seals shall be placed on sample containers immediately after sample collection and on shipping coolers if the cooler is to be removed from the sampler's custody. Custody seals will be placed in such a manner that they must be broken to open the containers or coolers. The custody seals shall be labeled with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed.

These seals are designed to enable detection of sample tampering.

Field personnel shall also log individual samples onto carbon copy chain-of-custody forms when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 2.4 indicating sample number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The samplers will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests.

2.3.2 Laboratory Custody Procedures

The following are custody procedures to be followed by an independent laboratory receiving samples for chemical analysis; the procedures in their Laboratory Quality Assurance Plan (LQAP) must follow these same procedures. A designated sample custodian shall take custody of all samples upon their arrival at the analytical laboratory. The custodian shall inspect all sample labels and COC forms to ensure that the information is consistent, and that each is properly completed. The custodian will also measure the temperature of the samples in the coolers upon arrival. The custodian shall also note the condition of the samples including:

- If the samples show signs of damage or tampering.
- If the containers are broken or leaking.
- If headspace is present in sample vials.
- Proper preservation of samples (made by pH measurement, except VOCs and purgeable TPH). The pH of these samples will be checked by the laboratory analyst, after the sample aliquot has been removed from the vial for analysis.
- If any sample holding times have been exceeded.

All of the above information shall be documented on a sample receipt sheet by the custodian.

Any discrepancy or improper preservation shall be noted by the laboratory as an out-of-control event and shall be documented on an out-of-control form with corrective action taken. The out-of-control form shall be signed and dated by the sample control custodian and any other persons responsible for corrective action.

The custodian shall then assign a unique laboratory number to each sample and distribute the samples to secured storage areas maintained at 4°C. The unique laboratory number for each sample, contractor sample ID, client name, date and time received, analysis due date, and storage details shall also be manually logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The custodian shall also sign the shipping bill and maintain a copy.

Laboratory personnel shall be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. Samples should be logged in and out on internal laboratory COC forms each time they are removed from storage for extraction or analysis.

2.4 COMPLETING CHAIN-OF-CUSTODY/ANALYTICAL REQUEST FORMS

COC form/analytical request completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form also is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Box 1 Project Manager: This name shall be the name that will appear on the report. Do not write the name of the Project Coordinator or point of contact for the project instead of the Project Manager.

Project Name: Write it, as it is to appear on the report.

Project Number: Write it as it is to appear on the report. It shall include the project number, task number, and general ledger section code. The laboratory subcontract number should also be included.

Box 2 Bill to: List the name and address of the person/company to bill only if it is not in the subcontract with the laboratory.

Box 3 Sample Disposal Instructions: These instructions will be stated in the Basic Ordering Agreement (BOA) or each Task Order statement of work with each laboratory.

Shipment Method: State the method of shipment, e.g., hand carry; air courier via FEDEX, AIRBORNE, DHL or equivalent.

Comment: This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis. For example: a specific metals list, explanation of Mod 8015, Mod 8015 + Kerosene, samples expected to contain high analyte concentrations.

Box 4 Cooler Number: This will be written somewhere on the inside or outside of the cooler and shall be included on the COC. Some laboratories attach this number to the trip blank identification, which helps track VOC samples. If a number is not on the cooler, field personnel shall assign a number, write it on the cooler, and write it on the COC.

QC Level: Enter the reporting/QC requirements, e.g., NAVFAC NW QC Level C, D, or E.

Turnaround time (TAT): TAT for contract work will be determined by a sample delivery group (SDG), which may be formed over a 14-day period, not to exceed 20 samples. Standard turnaround time once the SDG has been completed is 35 calendar days from receipt of the last sample in the SDG. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each COC to remind the laboratory.

Box 5 Type of containers: The type of container used, e.g., 1-liter glass amber, for a given parameter in that column.

Preservatives: Field personnel must indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Box 6 Sample number: Five-character alpha-numeric identifier to be used by the laboratory to identify samples. The use of this identifier is important since the labs are restricted to the number of characters they are able to use.

Description (sample identification): This name will be determined by the location and description of the sample. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer COC version is used, the sample identification can be input but printed with this block black. A cross-referenced list of sample number and sample identification must be maintained separately.

Date Collected: Collection date must be recorded in order to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

Time Collected: When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations; e.g., 1815 instead of 6:15 p.m. Record local time; the laboratory is responsible for calculating holding times to local time.

Lab Identification: This is for laboratory use only.

Box 7 Matrix and QC: Identify the matrix: e.g., water, soil, air, tissue, fresh water sediment, marine sediment, or product. If a sample is expected to contain high analyte concentrations, e.g., a tank bottom sludge or distinct product layer, notify the laboratory in the comment section. Mark an "X" for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) purposes. The sample provided for MS/MSD purposes is usually a field duplicate.

Box 8 Analytical Parameters: Enter the parameter by descriptor and the method number desired. When requesting metals that are modifications of the standard lists, define the list in the comment section. This would not be necessary when requesting standard list metals such as priority pollutant metals (PPM), target compound list from ILM03.0, and Title 22 metals which are groups of metals commonly requested and should not cause any confusion as to what metals are being analyzed. Whenever possible, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion.

In the boxes below the analytical parameter, indicate the number of containers collected for each parameter by marking an "X". If more than one container is used for a sample, write a number in the desired box to indicate a request for analysis and to indicate the number of containers sent for that analysis.

Box 9 Sampler's Signature: The person who collected samples must sign here.

Relinquished By: This space shall contain the signature of the person who turned over the custody of the samples to a second party other than an express mail carrier such as FEDEX, DHL or Air Borne Express.

Received By: Typically, this is a written signature by a representative of the receiving laboratory, or a field crewmember who delivered the samples in person from the field to the laboratory. A courier such as FedEx or DHL does not sign because they do not open the coolers. It must also be used by the prime contracting laboratory when samples are sent to a subcontractor.

Relinquished By: In the case of subcontracting, the primary laboratory will sign the Relinquished By space and fill out an additional COC to accompany the samples being subcontracted.

Received By (Laboratory): This space is for the final destination (e.g., at a subcontracted laboratory).

Box 10 Lab Number and Questions: This box is to be filled in by the laboratory only.

Box 11 Control Number: This number is the "COC" followed by the first sample number in a cooler, or contained on a COC. This control number must be unique and never used twice. Record the date the COC is completed. It should be the same date the samples are collected.

Box 12 Total No. of Containers/row: Sum the number of containers in that row.

Box 13 Total No. of Containers/column: Sum the number of containers in that column.

Because COC forms contain different formats based upon who produced the form, not all of the information listed in items 1 to 13 may be recorded. However, as much of this information as possible shall be included.

COC forms tailored to each Task Order can be drafted and printed onto multi-ply forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; TAT; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, reduce the number of trip blanks by placing all samples to be analyzed for VOA, gasoline, and BTEX compounds into one cooler. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

3.0 DOCUMENTATION

The COC/analytical request form shall be faxed daily, if possible, to the Task Order Laboratory Coordinator for accuracy verification. Following the completion of sampling activities, the sample logbook and COC forms will be transmitted to the Project Manager for storage in project files. The Project Manager shall review COC forms on a monthly basis at a minimum. The data validators shall also receive a copy. Along with the data delivered, the original COC/analytical request form shall be submitted by the laboratory. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

4.0 REFERENCES

State of California Water Resources Control Board. 1988. Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports.

USEPA. 1986. EPA NEIC Policies and Procedures, National Enforcement Investigations Center, Denver, Colorado.

USEPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA OSWER Directive 9355 3-01).

USEPA. 1992. RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD).

USEPA. 1995 and as updated. Test Methods for Evaluating Solid Waste (SW-846), Third edition.

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EQUIPMENT DECONTAMINATION

1.0 PURPOSE

The standard operating procedure (SOP) describes general methods of equipment decontamination (decon) for use by field personnel during field sampling activities. Some sites may require additional steps to ensure equipment is properly decontaminated. These should be identified and addressed in the QAPP.

2.0 PROCEDURES

Decontamination of equipment is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program should include consideration of the following factors:

- The location where the decon procedures will be conducted
- The types of equipment requiring decon
- The frequency of equipment decontamination
- The cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- The method for containing the residual contaminants and wash water from the deconning process
- The use of a quality control measure to determine the effectiveness of the decontamination procedure (e.g. equipment rinsate samples)

This subsection describes standards for decontamination, including the techniques to be used, frequency of decontamination, cleaning solutions, and effectiveness.

2.1 DECONTAMINATION AREA

An appropriate location for the decontamination area at a site shall be selected on the basis of the ability to control access to the area, control residual material removed from equipment, the need to store dirty and clean equipment, and the ability to restrict access to the area being investigated. The decontamination area shall be located an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

2.2 TYPES OF EQUIPMENT

Examples of drilling equipment that must be deconned includes drill bits, auger sections, split spoon samplers, and hand tools. Decontamination of monitoring well development and ground-water sampling equipment includes submersible pumps, non-disposable bailers, interface probes, water level meters,

bladder pumps, airlift pumps, and lysimeters. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and should be properly disposed of after one use.

2.3 FREQUENCY OF EQUIPMENT DECONTAMINATION

Down-hole drilling equipment and equipment used in monitoring well development and purging shall be decontaminated prior to initial use and between each borehole or well. However, down-hole drilling equipment may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, the drilling tools shall be decontaminated prior to drilling deeper. Groundwater sampling should be initiated by sampling ground water from the monitoring well where the least contamination is suspected. This is more important when not using disposable equipment. All groundwater, surface water, and soil sampling devices shall be decontaminated prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

2.4 CLEANING SOLUTIONS AND TECHNIQUES

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment such as drill bits, augers, drill string, pump drop-pipe, etc., is steam cleaning. Steam cleaning is accomplished using a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, equipment shall be thoroughly steam washed and rinsed with Poly- and Perfluoroalkyl Substances (PFAS) free water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (Citrinox®, Liquinox®, or other suitable phosphate-free detergent) and PFAS-free water, and (2) rinse with PFAS water. Equipment shall be disassembled as much as is practical, prior to cleaning. An initial gross wash scrub down and quick rinse should be completed at the beginning of the process if equipment is heavily soiled. After decontamination, care needs to be taken that the cleaned equipment does not become contaminated. This may require wrapping items in foil or plastic and storing the equipment in a specified “clean” area.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. The pumps shall be decontaminated by circulating fluids through the pump while it is operating. This circulation can be done using a clean 4-inch or greater diameter pipe equipped with an end cap. The pipe shall be filled with enough decon fluid to submerge the pump, the pump placed within the capped pipe, and the pump operated while circulating the fluids within the pipe. The decontamination sequence shall include (1) detergent and PFAS-free water, and (2) PFAS-free water rinse. The decontamination fluids shall be changed after each cycle. Changing of the fluids may include dumping of the detergent water, mixing detergent in the potable water rinse, using the deionized water as the potable rinse and renewing the distilled/deionized water. All decon water shall be disposed of as outlined in the field work plans.

Equipment used for measuring field parameters such as pH, temperature, specific conductivity, and turbidity shall be rinsed with PFAS water.

2.5 CONTAINMENT OF RESIDUAL CONTAMINANTS AND CLEANING SOLUTIONS

Decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water. This may require setting up a containment area with a system for pumping the generated decontamination water into proper containers.

Clean equipment should be stored in a separate location to prevent recontamination. Decontamination fluids contained within the bermed area shall be collected and disposed of as outlined in the field sampling plan.

Containment of fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices shall be accomplished using wash buckets or tubs. The decontamination fluids shall be collected and disposed of as outlined in the field sampling plan.

2.6 EFFECTIVENESS OF DECONTAMINATION PROCEDURES

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment rinsate samples or wipe testing. Equipment rinsates consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. Further descriptions of these samples and their required frequency of collection are provided in SOPs B and E. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

3.0 DOCUMENTATION

The decontamination process shall be recorded in the field logbook.

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APPENDIX B

Data Management Plan

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APPENDIX B:

Draft Data Management Plan

PFOS/PFOA Preliminary Assessment/ Site Inspection
Joint Base Lewis-McChord, Washington

Prepared for:

U.S. Army Corps of Engineers
Seattle District

Prepared Under:

U.S. Contract No. W912DQ-15-D-3011
Task Order W912DW17F2085

Prepared by:

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Appendix B-1. Tabular Data/EQuIS Specifications

ACRONYMS AND ABBREVIATIONS

2-D	Two-dimensional (e.g. map view, not elevation vertex)
3-D	Three-Dimensional (includes elevation vertex)
AD	Windows Active Directory
AFFF	Aqueous Film Forming Foam
BRH	Bush, Roed & Hitchings (professional land surveyor)
CAD	Computer-aided Design
COC	Chain of Custody
CORS	Continuously Operating Reference Station
CPU	Central Processing Unit
DBF	dBASE Format
DMP	Data Management Plan
DoD	Department of Defense
DVA	Data Validation Assistant
EDD	Electronic Data Deliverable
EDP	Electronic Data Processor
FGDB	File Geodatabase
FGDC	Federal Geographic Data Committee
GCS	Geographic Coordinate System
GIS	Geographic Information Systems
GPS	Global Positioning System
JBLM	Joint Base Lewis McChord
LHA	Lifetime Health Advisory
LiDAR	Light Detection and Ranging
LUT	Look-up Table
MLLW	Mean Low Low Water
MSL	Mean Sea Level
MS	Microsoft
MW	Monitoring Well
NAD83	North American Datum of 1983 (Horizontal Datum)
NAVD88	North American Vertical Datum of 1988
PA/SI	Preliminary Assessment / Site Inspection

PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
POC	Point of Contact
QA/QC	Quality Assurance / Quality Control
RDBMS	Relational Database Management System
RGB	Red, Green, Blue
SDTS	Spatial Data Transfer Standard
SOP	Standard Operating Procedures
SQL	Structured Query Language
SW	Surface Water
TDB	To Be Determined
TIFF	Tagged Image File Format
UOM	Unit of Measure
URL	Uniform Resource Locator
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VPN	Virtual Private Network
WGS	World Geodetic System

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1. Introduction

1.1 Project Background

Joint Base Lewis McChord (JBLM) is a U.S. military facility located 9.1 miles south-southwest of Tacoma, Washington, consisting of four geographical areas, Lewis Main, Lewis North, McChord Field, and Yakima Training Center. The area referred to as Fort Lewis proper contains 86,000 acres. It is located in Township 25 North, Range 4 East, Section 2, in Pierce County, Washington, and has the geographical coordinates of 47°06'21" north latitude and 122°35'52" west longitude (see Figure 1).

The U.S. Army Corps of Engineers (USACE) is conducting a preliminary assessment/site inspection (PA/SI) of Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) in groundwater at JBLM in response to a Lifetime Health Advisory (LHA) released by United States Environmental Protection Agency (USEPA). In May 2016, the USEPA issued a LHA level in drinking water of 70 parts per trillion (ppt; or 0.07 µg/L) for PFOS/PFOA (individually or combined if both are detected in drinking water). EPA's LHA levels include a significant margin of safety to ensure they are protective of the most sensitive sub-populations while drinking the water over a lifetime.

Per- and polyfluoroalkyl substances (PFAS) are manufactured fluorinated organic chemicals that have been used in a wide variety of industrial and commercial products due to their valuable properties including fire resistance, dust suppression, and oil stain, grease and water repellence. PFAS are persistent in the environment and have been found in surface water, soils, and groundwater.

The Army implemented a comprehensive PFOS and PFOA testing program at DoD facilities that may have used aqueous film forming foam (AFFF) or other PFOS/PFOA-containing products. On June 10, 2016 Department of Army instructed all Army installations to conduct PFAS contamination assessments for known fire training areas, AFFF storage locations, hangars/buildings with AFFF suppression systems, fire equipment maintenance areas, and areas where emergency response operations required AFFF use as possible source areas.

At JBLM, AFFF was used for firefighter training at several locations on the east side of McChord Field's runway and on Lewis Main's Gray Army Airfield since 1970 through the early 1990's. The use of AFFF that contain PFAS was discontinued more than 20 years ago. JBLM firefighters no longer train with this product. Some hangers were also fitted with AFFF fire suppression systems and may be potential source areas for PFOS/PFOA. JBLM identified up to six historic fire training areas that could be potential sources for the drinking water

contamination (Figure 1). There are no known records reviews of previous emergency response actions at JBLM that may have used AFFF containing PFASs.

Based on drinking water testing completed to date at JBLM, five (5) wells were above the 70 parts per trillion level. Three (3) wells at McChord field (North, South, and Housing Well #2,), one (1) at Lewis Main (Well # 17) and one (1) at Eagles Pride golf course (Well # 22), exceeded the EPA LHA (Figure 1).

1.2 Purpose and Scope

The purpose of this Data Management Plan (DMP) is to provide a central and complete reference to address all the key requirements associated with creating, securely collecting, managing and transmitting final high quality tabular and geospatial work products associated with the JBLM PA/SI. The DMP defines the file directory architecture and security, tabular and geospatial data standards, and workflows for field data collection, data loading, creation of data work products, QA/QC, and final transmittal of work products to USACE.

1.2.1 Goals and Objectives

The goals and objectives of this Data Management Plan are defined in this section as follows:

1. Ensure that environmental data and supportive information are collected and managed in a manner that preserves, protects, and makes the information available to all stakeholders, performing parties, and other affected groups

2. Provide standardization of processes to manage and transmit environmental and regulatory data.

3. Ensure efficient use of data among all project members and stakeholders to minimize errors and rework due to misunderstandings about the data's content, geodetic parameters, version or format.

4. Provide a clear origin, date, and correlation of historical and new data to derivative work products developed during data interpretation and analysis.

5. Implement and operate geospatial and tabular data repositories that are secure and capable of supporting the needs of the project.

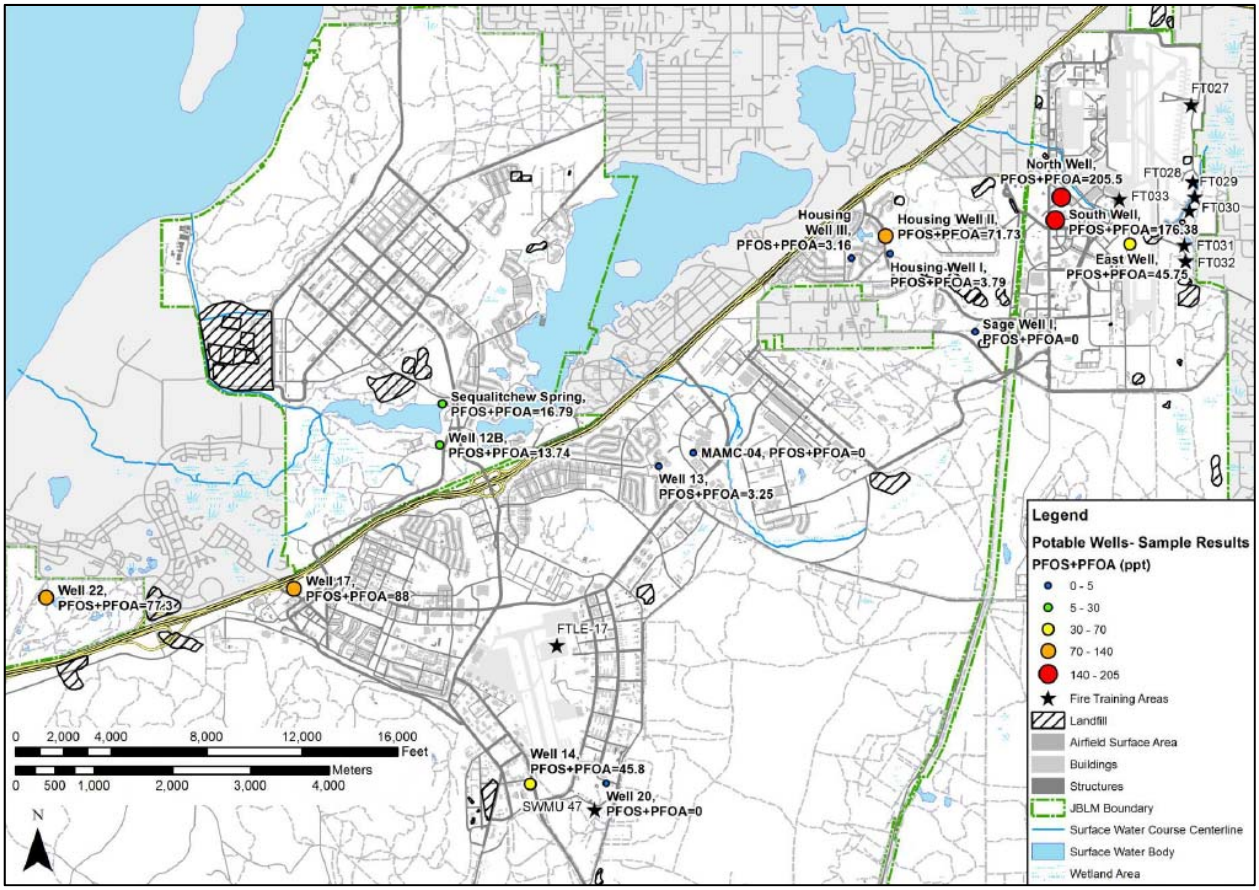

Figure 1. Project Location Map

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2. Information Repository Configuration

This section summarizes the software platform / version, directory architecture, security and accessibility specifications of the project information repository, and the roles and responsibilities of data management personnel supporting the project.

2.1 System Software

The key software platforms and versions that will be used to support the project are listed below in Table 1. Other add-ons, extensions, and specialty software products that may be used on the project are not included but will be referenced in project deliverables as appropriate.

2.2 System Architecture, Security, Back-up

The basic configuration and location of File server(s), the Database server, and other internal network project resources are summarized in Table 2 below. AECOM will maintain a secure network and server infrastructure through a Windows Active Directory (AD) User ID and password implementation, along with company personal identity and network appliance protective measures. AECOM users working from remote locations will use the AECOM Virtual Private Network (VPN) login utilities and policies, and company intranet/network requirements when in the office. AECOM will follow network and enterprise resource backup, archiving, and retainage procedures relevant to AECOM company policies, and the terms and conditions of contracts/subcontracts relevant to the project and USACE.

2.3 Data Manager Roles and Responsibilities

The key roles and responsibilities of team members with an emphasis on data management activities are summarized below in Table 3. All team members working with tabular or geospatial data will have a minimum of five (5) years of experience with respective tools and platforms relevant to their data management tasks, or work under the supervision of persons with this level of experience.

Table 1. Primary Software

Description
Geographic Information Systems (GIS)
ESRI ArcGIS® Advanced, Standard 10.5.1
Global Positioning Systems (GPS)
ESRI ArcPad10.2, Trimble TerraSync 5.4.1 (Conventional)
ESRI Collector, Trimble Terraflex (WiFi/Mobile)

Data Management
EQuIS Professional V6.6.0
MS SQL Server 2013 / SQL Server Management Studio
AECOM EDD Format V2.5.3 (Internal Use)
EQuIS EQEDD V6.6 (USACE Submittals)
Project Collaboration
MS Office 2010

Table 2. Network Mappings

Primary Purpose	Pathway/URL
Primary Project Directory	\\Seattle.na.aecomnet.com\DCS\Projects\ENV\ 60555402_JBLM_PASI
EQuIS Project Database	NADTC1PSQLW003.NA.AECOM
Geospatial Base Layer Data	\\Seattle.na.aecomnet.com\DCS\GIS\GIS_Library\Data

Table 3. Data Manager Key Roles and Responsibilities

Role	Person(s)	Role Responsibilities
Data Manager	Mike Surowiec	Data Management lead responsible for development and implementation of standards, procedures and processes to produce high quality tabular and geospatial data.
Data Analyst	Michelle McClelland Jody Lovell Ian Sahlberg	Responsible for monitoring and QA/QC of incoming field data, preparing EQuIS EDDs and loading to Project Database, archiving raw data files to network, preparing and transmitting tabular data deliverables to USACE.
GIS Staff	Cary Kindberg Mason Struna	GIS staff responsible for GPS operation and/or review of surveyor data, GIS analysis, and preparation of geospatial deliverables to meet project requirements.

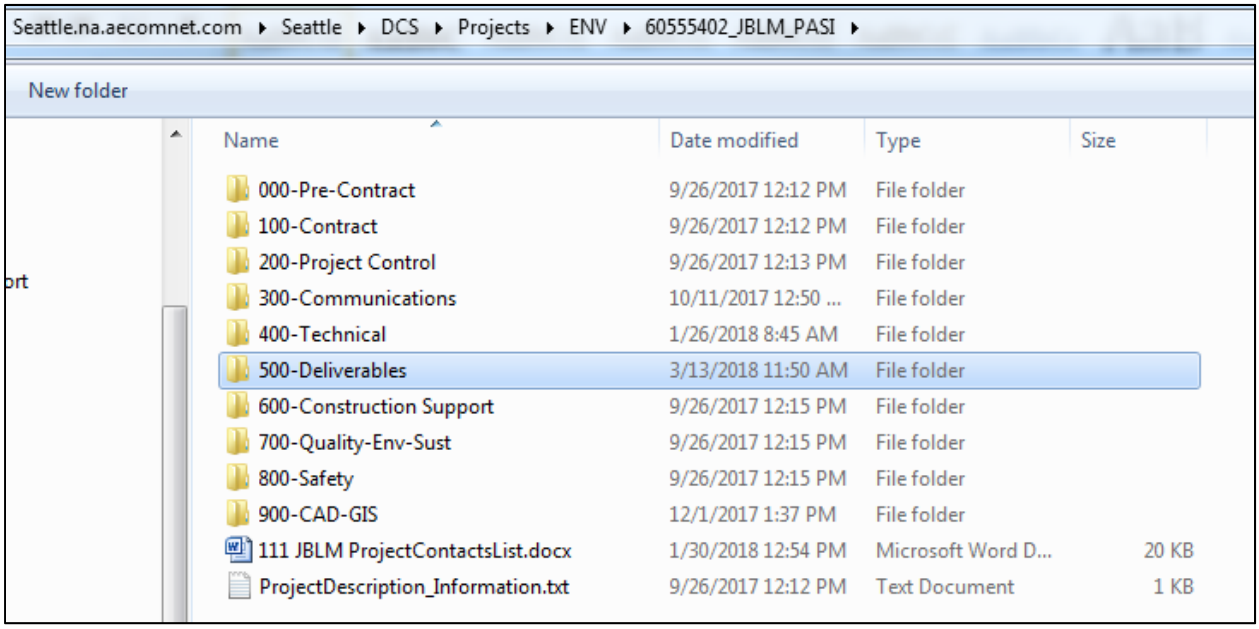

Figure 2. Project Directory Root

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3. Tabular Data Standards

This section of the DMP summarizes the tabular data standards to be used on the project including: the EQuIS Project Database specifications, internal AECOM EDD specifications, naming conventions for locations/ samples, minimum field data documentation, USACE data transmittal requirements, and treatment of historical datasets.

3.1 Project Database

AECOM will use EQuIS Professional V6.6.0 as the Project Database and central repository for all new and the limited historical tabular data for JBLM. The Project Database will reside on the AECOM intranet, implemented on an MS SQL Server platform. EQuIS will be the master data repository for all locations, samples, analytical chemistry results, field measurements, and other content in a tabular format. While location/positional data for up to 30 new monitoring wells is anticipated to be received in AutoCAD Civil 3D, version 2014 format from the subcontracted surveyor (Bush, Roed & Hitchings [BRH]), the master repository of final surveyed point data will be the EQuIS Project Database Location table. File geodatabases (FGDB) will be used as master repositories for geospatial data captured in line or point geometry format (see Section 4.0 for more detail). Additional details are provided below regarding the overall project data specifications, EDD format, location/sample nomenclature/ minimum data field requirements, and USACE data transmittal standards.

3.1.1 Tabular Data Specifications

The EQuIS data model is quite large (> 300 tables) and customizable, and not all the table constructs are necessary or will be used on the JBLM project. The primary table constructs intended to be used are as follows:

- Project
- Facility
- Location
- Sample
- Analytical Results
- Field Measurements

Overall electronic data deliverable (EDD) specifications for the primary, reference and domain tables for the above content areas are included in Appendix B-1. Specifically, the AECOM V2.5.3 EDD format will be used to load new data to the EQuIS Project Database. Location, Sample, and Analytical Results will be the primary EDDs loaded directly to the Project

Database. Support laboratories will be directed to provide data in the AECOM Analytical Results V2.5.3 EDD format. For some higher level project information (e.g. Facility ID) either import scripts or the EQuIS forms interface may be used to enter seed data.

3.1.2 Location / Sample Nomenclature

The naming conventions / nomenclature to be applied to locations and samples are summarized in this section through tables and descriptions. A unique naming and numbering scheme for new well locations will be critical to maintaining data integrity and to allow the reliable joining of tabular data to spatial representations of that data on maps. This will also maximize consistency in data management procedures between field staff, data management staff, and other project team members.

For new monitoring wells, it is proposed that the unique Location ID consist of a prefix designating the year corresponding to the monitoring well installation date (i.e. 2018) followed by a location type prefix (MW= Monitoring Wells) and a sequential number. The sequential number will be assigned based on the order in which the wells are installed. At this time, the only other location type anticipated is surface water which will be designated using a prefix of SW followed by a sequential number. Leading zeros are proposed for all sequential numbers to facilitate alpha-numeric sorting in tables when performing subsequent analysis. The unique Location ID naming paradigm is summarized in Table 4.

The Sample ID nomenclature is also deemed critical to maintaining project data integrity and will be correlated to the Location ID. The Sample ID will consist of the location naming codes defined in Table 4 for new wells, or the existing monitoring well name (per SAP Worksheet #18 of the QAPP) plus the sample date in YYMMDD format. The unique Sample ID naming paradigm is summarized in Table 5. Quality control sample designations addressed in the QAPP (SAP Worksheet #17) are also summarized in this table.

3.1.3 Minimum Field Data Documentation

All field data collection efforts will be documented in paper logbooks and forms as specified in the following SOPs included in Appendix A of the QAPP. These SOPs specify minimum data requirements for this documentation. For the purposes of loading data to the Project Database and maintaining data integrity, the Location ID and Sample ID naming conventions must be implemented and recorded accurately in the field documentation, chain-of-custody forms, and laboratory deliverables.

- SOP L: Field Documentation (primary reference)
- SOP B- GW Sampling (documentation section)

- SOP H-MW Install (documentation section)

3.1.4 USACE Data Submittal Standards

AECOM has received no technical direction or specific data submittal standards for JBLM tabular data transfer to USACE. Accordingly, AECOM intends to transmit tabular data that is loaded into the Project Database to USACE after all final loading and QA/QC steps are complete using the EQuIS EQEDD format (.CSV or .TXT load format). The following general content is anticipated to be transmitted in this format:

- Locations
- Samples
- Analytical Results
- Field Measurements

Other data that to be collected will be transmitted as follows:

- Lithologic Data: Borehole Diagram, PDF format
- Well Construction: Well Completion Diagram, PDF format
- Field Photographs: Native .JPG format

3.2 Tabular to Geospatial Operations

As described at the beginning of this section, EQuIS will be the master data repository for all locations, samples, analytical chemistry results, field measurements, and other content to be stored in a tabular format. While location/positional data will be captured by subcontractor BRH, the master repository of final, location point data will be the EQuIS Project Database Location table. Here unique Location IDs and location coordinates will be stored for all point data, or point data representations (e.g. centroids) of other spatial geometries (line or polygon). When tabular data is "attached" to spatial features or utilized in maps, user and project-specific tabular data exports will be prepared that can be imported to GIS to create maps and perform geospatial analyses. The exports are expected to be Excel, CSV, or other delimited text file format generated through SQL queries to the Project Database. The export will always include a unique Location ID / index that can be joined to the geospatial point or object in a feature class. Additional details on this process can be found in Section 5.

3.3 Historical Data

It is anticipated that only limited historical tabular datasets will be loaded to the Project Database primarily related to PFC-related analytical chemistry data from several sampling rounds from the production wells described in Section1. Along with these datasets, existing monitoring well locations to be sampled as part of the PA/SI as referenced in SAP Worksheet #18, will be loaded into the Project Database. Any assumptions, rules, or backfilling of missing data that are needed to enter this data to the Project Database will be fully documented.

Table 4. Location Naming Codes

Year Reference	Location Type	Location Type Prefix	Example Complete Location ID
2018	Monitoring Well	MW	2018-MW-001 2018-MW-002 2018-MW-003
Not Applicable	Surface Water	SW	SW-001

Table 5. Sample Naming Codes

Location ID	Sample Description	Example Sample ID
2018-MW-001	New monitoring well sample collected May 18, 2018	2018-MW-001-180530
SW-001	Surface water sample collected May 18, 2018	SW-001-180530
LT-4	Existing monitoring well sample collected May 18, 2018	LT-4-180530
Not Applicable*	Monitoring well duplicate sample collected May 18, 2018	GWDUP01-180530
Not Applicable*	Surface water duplicate sample collected May 18, 2018	SWDUP01-180530

Location ID	Sample Description	Example Sample ID
Not Applicable	Field rinsate blank collected May 18, 2018	FRB01-180530

***** The Location ID for blind field duplicates will be recorded in the field log book

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4. Geospatial Data Standards

This section of the DMP summarizes the geospatial data standards to be used on the project including: geodetic standards, data format, data quality and precision, topology, and metadata.

4.1 Geodetic Standards

The project geodetic standards discussed in this section include required project datums and coordinate system parameters.

4.1.1 Vertical Datum

The new monitoring well locations for this project in general will be recorded in three-dimensional (3-D) geometry and will use the vertical datum standard of North American Vertical Datum of 1988 (NAVD88). The land surveyor subcontractor BRH will provide conversion factors to calculate the elevation data relative to the current Epoch of Mean Low Low Water (MLLW) and Means Sea Level (MSL). Existing monitoring well locations to be loaded to the Project Database are presumed to comply with the same vertical datum requirements.

4.1.2 Horizontal Datum

The horizontal datum standard that will be used for new monitoring well location is North American Datum 1983 (NAD83), Washington State Plane South Zone. The same horizontal datum is presumed for existing monitoring well locations.

4.2 Geospatial Data Standards

The geospatial data model will be an extension of the tabular data specifications described in Section 3.0 and Appendix B-1. EQuIS will be the master data repository for all locations, samples, analytical chemistry results, field measurements, and other content in a tabular format. Although the location/positional point data is inherently geospatial, the master repository of final, post-processed point data will be the EQuIS Project Database Location table. File geodatabases will be used as master repositories for geospatial data captured in line or point geometry format.

The data requirements for the geospatial portion of the project dataset is expected to consist of three broad groupings: 1) Historical Data 2) New Monitoring Well Data, 3) Derivative Work Products. It is expected that these geospatial datasets will have varying degrees of quality and completeness with regard to attributes, standardized data codes, precision, etc. The standardization of geospatial datasets is described in more detail below.

4.2.1 Historical Data

Historical data is presumed to include existing aerial imagery, base layers, and well locations provided to AECOM by JBLM and USACE. It is proposed that this data be used "as is" and only reviewed and organized for the purposes of PA/SI figure production. Historical monitoring well and production well point data will also be used "as is" for the purpose of figure production, but location coordinates will be extracted and loaded as tabular data to the Project Database, Location table to meet its minimum data requirements. Alternatively, AECOM may ground-truth these existing well locations using a differential GPS and use these location coordinates in figures and/or load this positional information into the Project Database instead.

4.2.2 New Monitoring Well Data

The new geospatial data to be collected as part of the PA/SI is associated with up 60 monitoring well locations. BRH will survey top of casing, top of PVC pipe elevation, and map coordinates for the monitoring wells specified by AECOM. AECOM expects to receive an AutoCAD Civil 3D, version 2014 .DWG file (or equivalent) for the surveyed locations according to the geodetic standards specified in Section 4.1. These data points will be extracted using ArcGIS, put into a tabular format, and then will be loaded to the Project Database Location table.

4.2.3 Derivative Work Products

Derivative work products may include concentrations isopleths, volumetric calculations, mass loading calculations, and other content developed from geospatial analysis. The naming conventions, attribution, domain values, topology, and other specifications for this content have yet to be fully determined. In general, it is anticipated that ESRI Map Packages will be prepared to support any work products of this nature providing full metadata, supporting feature classes, .MXDs, layer files and other content for a self-contained deliverable.

4.3 Precision and Data Quality

4.3.1 Vector Datasets

General vector dataset precision and quality requirements are as follows:

- Vector data shall only be permissible in an ArcGIS feature class and feature datasets format. Shapefiles are allowed only if authorized by the project.
- Vector data will be managed and edited using ArcGIS.
- Attributes for shapefiles shall be in a tabular dBASE format.
- Vector datasets shall be natively stored in geographic coordinates and expressed in Decimal Degrees and will include a horizontal datum definition, or Washington State

Plane South Zone (Feet) coordinate system (as defined in Section 4.1.3) when used for calculating length and area as long as properly documented; and

- Data will be stored as Double Precision, with a minimum precision of eight (unless otherwise indicated).
- Contain Proper Negative Values for Longitude.

Point dataset precision and quality requirements are as follows:

- Datasets shall be represented by a pair of double-precision coordinates in the order of Northing / Easting or Latitude / Longitude.
- All point datasets shall adhere to applicable point topology and complete attribution.

Polyline dataset precision and quality requirements are as follows:

- Polyline datasets shall start, finish, and only connect to one another at nodes, edges, or vertices.
- All polyline datasets shall contain arc topology and complete attribution.
- It is not acceptable for polyline datasets to contain self-intersections, or to extend through nodes (i.e., it is unacceptable to have the right and left polygons equal the same polygon).

Polygon dataset precision and quality requirements are as follows:

- Polygon datasets shall be represented by closed polygons with only one label point
- The interior edge shall be defined in a counter-clockwise direction, and each polygon dataset shall be edge-matched across projection zones.

4.3.2 Raster Datasets

No new raster datasets are anticipated at this time, however, general raster dataset precision and quality requirements are as follows:

- Imagery derived from sub-sampling techniques or from lossy compressed sources shall be noted in metadata when known.
- Raster image files created through satellite imagery, aerial photography, or scanning shall be delivered as uncompressed tagged image file format (TIFF) or geoTIFF files and shall include a TIFF world file (.tfw).
- The TIFF file datasets must have row-major orientation, non-planar configuration, and be non-tiled.
- Other bi-level images that are acceptable are (ECW) and multi-resolution (MrSID) images with compression ratios equal to or greater than 1:10.
- Any other lossy or lossless compression formats will be noted.

- Bi-level images (1-bit, composed of black and white colors only) should be stored using lossless image compression as outlined in the TIFF Revision 6.0 document.
- Full color images (i.e., pixels made up of red / green / blue [RGB] components) should contain a color map or palette.
- Palette color images should have their component value referenced to a full red / green / blue Look-up Table (LUT).

Scanned maps precision and quality requirements are as follows.

- The method of creating raster imagery through scanning hardcopy maps shall be done using a minimum scanning resolution of 100 microns or 254 dpi.
- The raster image accuracy must exceed the original map scale and meet the minimum standard as follows:
  - Scale 1:10,000 – Required Accuracy is 6 feet / 2 metes;
  - Scale 1:50,000 – Required Accuracy is 15 feet / 5 meters; and
  - Scale 1:250,000 – Required Accuracy is 75 feet / 25 meters.

4.4 Metadata Standards

The required project metadata standards, including any minimum requirements are described in this section.

4.4.1 Format

Metadata shall have a base name identical to its corresponding spatial export file, and shall be delivered in an .xml format that is compatible with the Federal Geographic Data Committee (FGDC) output Standards (https://www.fs.fed.us/gac/metadata/index.html).

4.4.2 Content Standards

Metadata shall be considered compliant with the FGDC Standard when all required information is provided. This includes information for all mandatory elements—plus information for all mandatory if applicable elements when relevant to the dataset. In addition to meeting these minimum requirements, additional elements deemed optional by the FGDC may be considered mandatory if applicable.

The project-specific mandatory if applicable elements are:

FGDC Section 1: Identification Information

- Point of Contact

- Data Set Credit
- Security Information

FGDC Section 2: Data Quality Information

- Quantitative Attribute Accuracy Assessment
- Quantitative Horizontal Positional Accuracy Assessment
- Quantitative Vertical Positional Accuracy Assessment
- Process Contact

FGDC Section 3: Spatial Data Organization Information

- Point and Vector Object Information
- Spatial Data Transfer Standard (SDTS) Terms Description
- Point and Vector Object Count
- Raster Object Information

FGDC Section 4: Spatial Reference

- No additional information required

FGDC Section 5: Entity and Attribute Information

- Attribute Value Accuracy Information

FGDC Section 6: Distribution Information

- Technical Prerequisites

FGDC Section 7: Metadata Reference Information

- Metadata Review Date
- Metadata Access Constraints
- Metadata Use Constraints
- Metadata Security information

FGDC Section 8: Citation Information

- No additional information required

FGDC Section 9: Time Period Information

- No additional information required

FGDC Section 10: Contact Information

- No additional information required

5. Field Operations / Data Workflow

This section summarizes the data workflow and operations anticipated specifically during field data collection activities. The section includes a summary of data-related field preparation activities, data-oriented training and laboratory communications, and the data processing activities to be conducted during field operations including loading of data to the EQuIS Project Database.

5.1 Field Preparation / GPS Support

The data-related activities expected in preparation of field deployment include configuration of Trimble R1 (or equivalent) GPS units and identifying ground control if used as a supplement to professional land surveying, and finalizing paper or electronic field data collection procedures and forms. It is anticipated that field staff/technicians operating GPS equipment or involved in field data collection will be trained in the minimum field data recording requirements including the use of unique Location IDs, Sample IDs, and other nomenclature requirements defined in Section 3 of this document.

5.2 Sample and Lab Requirements

The complete requirements for sample data collection and laboratory support are described in the Quality Assurance Project Plan and related SOPs and are only summarized here. Samples will be numbered according to the nomenclature defined in Section 3.1.3. The names of the electronic files, scanned field books/forms, etc. are also expected to follow these naming conventions. The contracted laboratories for this project are already familiar with the AECOM v2.5.3 EDD and analytical results deliverable requirements. They are expected to use this EDD format and the related EQuIS Electronic Data Processor (EDP) tool; reference values and upload instructions will be communicated to them prior to the start of field work. AECOM anticipates that contracted labs will utilize the EDP tool to check their completed analytical result EDDs prior to transmission to the data management team.

5.3 Office-based Data Processing

The procedures for managing incoming data from field staff are described in this section. Subsections include details on potential data transcription procedures, file organization, EDD management and upload of data to the Project Database.

5.3.1 Incoming Data Management and Transcription

Dedicated data management personnel identified in Table 3 will provide support regarding field data incoming to the office. They are expected to collect and remove data/files from electronic

devices (cameras, GPS, etc.); collect, organize, and scan any paper forms or field book entries to PDF format; assist with sample containers management and tracking; assist with field equipment troubleshooting; perform rudimentary data file completeness checks and inform field staff of incomplete or problematic data sets.

It is anticipated that some of the incoming data may need to be transcribed or otherwise re-purposed to an electronic format for ultimate loading to the EQuIS Project Database. Data management staff are expected to perform the transcription as well as manage/organize files of photos, scanned documents, or other paper and electronic content. It is anticipated that content transcribed from paper forms will require additional actions or staging for conversion to AECOM EDD format. Clean-up actions may include backfilling of any missing attributes, cross-checking of appropriate data codes, verification of proper Location IDs, etc. Incoming field data and prepared EDDs will be managed on the AECOM network and project directory discussed in Section 2 and depicted in Figure 2.

5.3.2 Tracking Samples and Lab EDDs

Data management staff will assist in sample tracking and organization of scanned Chain of Custody (COC) forms via a tracking workbook which will be stored and managed in the project directory. They will track and confirm when laboratories receive the packages, and monitor for the submittal and receipt of laboratory results in the AECOM v2.5.3 EDD format. These are expected to be posted by the laboratories in their respective, secure Internet-based file drop areas. After the EDDs are received from the labs, data management staff will back them up to the network project directory and stage them for loading to the Project Database.

5.3.3 EQuIS Project Database Operations

EQuIS database operations will consist of the project database setup, seeding of reference values, seeding of Project and Facility (i.e. JBLM facility) data, and sequential loading of Location, Sample, and Analytical Result EDDs. EQuIS Professional v6.6.0 desktop, the EDP module, and the AECOM v2.5.3 formatted EDDs will be the primary tools used to load data to the Project Database. Figure 3 depicts the desktop interface for Location data loading as an example.

Some data entry operations may be performed through the EQuIS forms interface, or via SQL insert scripts executed through the SQL Server Management Studio command line. Depending on the format received, some field measurement data may be loaded this way. These tools will more likely be used to make adjustments to data already loaded into the Project Database.

After the data is loaded to EQuIS, a number of QA/QC checks will be performed to verify completeness and condition of data inside the master repository. Data QA/QC will consist primarily of comparing row counts from the EDDs to the loaded number of records to the

appropriate EQuIS tables. The EDP data-checking module is expected to capture any valid values issues prior to loading into the database, so such checks are not anticipated. A content/logic cross-check to verify the hierarchy of Locations to Samples, and Samples to Analytical Results will also be performed to ensure the correct association of chemistry results to field locations. Completion of these tasks will be tracked in workbook stored in the project directory.

In addition, the EQuIS Data Validation Assistant (DVA) module will be used to facilitate the proper flagging of analytical data qualifiers by project chemists. This EQuIS tool creates an Excel workbook, similar to the one depicted in Figure 4, which will be provided to Project Chemists and/or 3rd-party validators to apply their qualifier flags in specific blank columns. The tool will be used to export loaded project analytical chemistry data in batches, the chemist will apply their flags and return the workbooks for synchronization with EQuIS. In order for the synchronization to work properly, it will be critical for the validators to us the workbook "as is" and not modify columns/content other than apply their proper validation codes in the indicated columns.

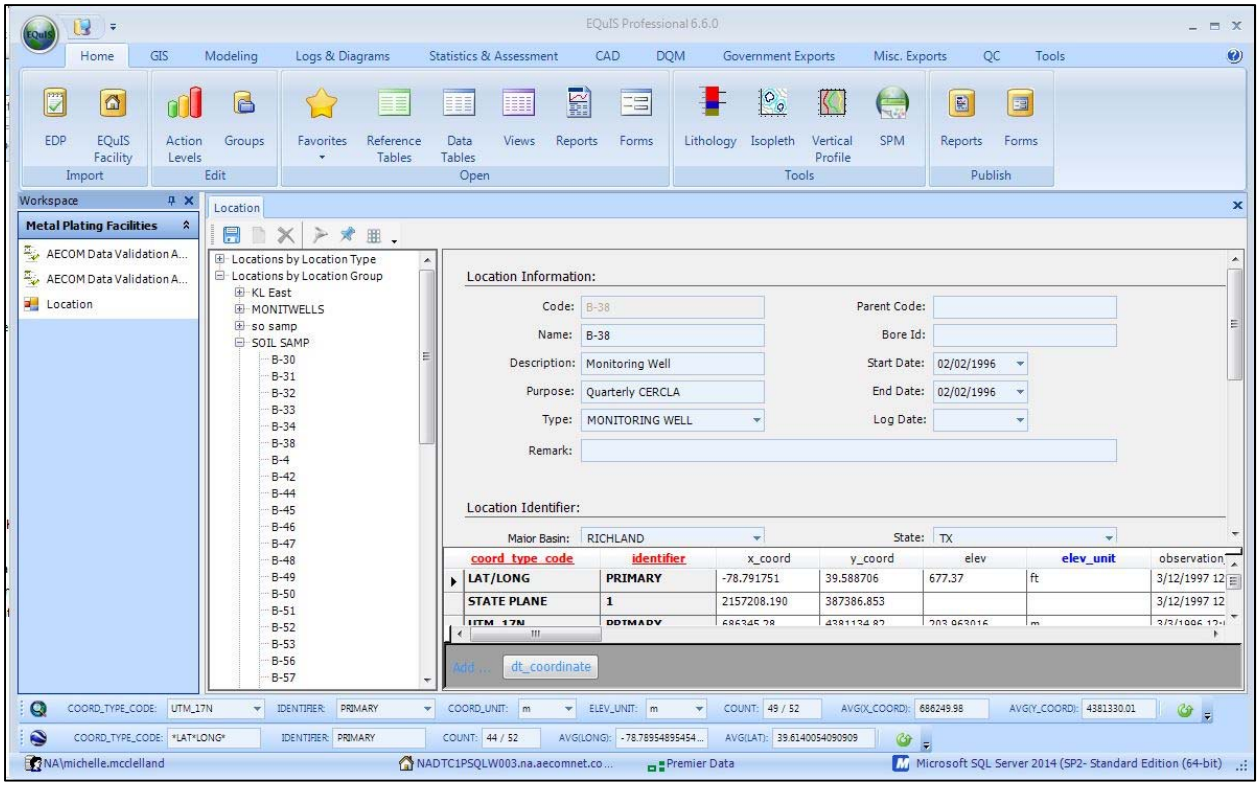
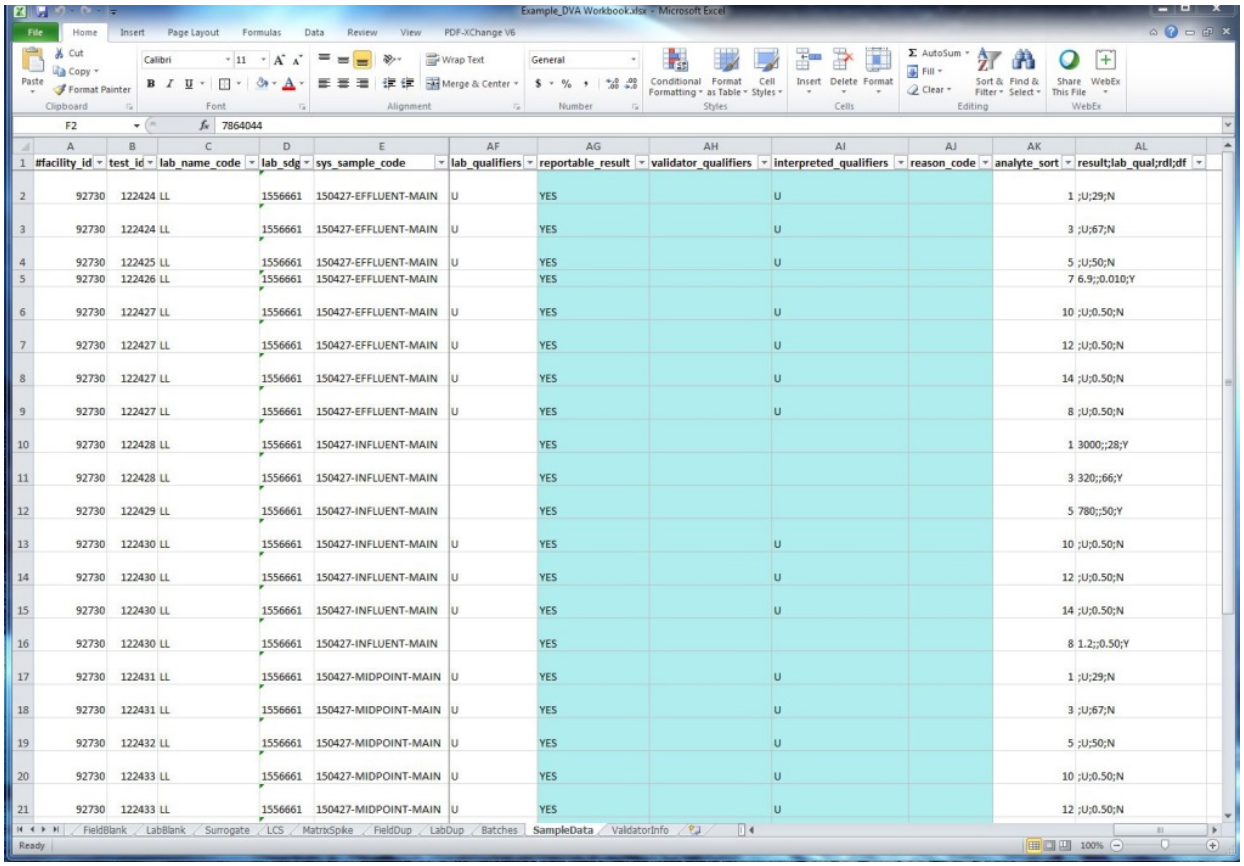


Figure 3. EQuIS Professional User Interface



#facility_id	test_id	lab_name_code	lab_sdg	sys_sample_code	lab_qualifiers	reportable_result	validator_qualifiers	interpreted_qualifiers	reason_code	analyte_sort	result;lab_qual;rdl;df
92730	122424	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		1	;U;29;N
92730	122424	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		3	;U;67;N
92730	122425	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		5	;U;50;N
92730	122426	LL	1556661	150427-EFFLUENT-MAIN		YES				7	6.9;;0.010;Y
92730	122427	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		10	;U;0.50;N
92730	122427	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		12	;U;0.50;N
92730	122427	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		14	;U;0.50;N
92730	122427	LL	1556661	150427-EFFLUENT-MAIN	U	YES		U		8	;U;0.50;N
92730	122428	LL	1556661	150427-INFLUENT-MAIN		YES				1	3000;;28;Y
92730	122428	LL	1556661	150427-INFLUENT-MAIN		YES				3	320;;66;Y
92730	122429	LL	1556661	150427-INFLUENT-MAIN		YES				5	780;;50;Y
92730	122430	LL	1556661	150427-INFLUENT-MAIN	U	YES		U		10	;U;0.50;N
92730	122430	LL	1556661	150427-INFLUENT-MAIN	U	YES		U		12	;U;0.50;N
92730	122430	LL	1556661	150427-INFLUENT-MAIN	U	YES		U		14	;U;0.50;N
92730	122430	LL	1556661	150427-INFLUENT-MAIN		YES				8	1.2;;0.50;Y
92730	122431	LL	1556661	150427-MIDPOINT-MAIN	U	YES		U		1	;U;29;N
92730	122431	LL	1556661	150427-MIDPOINT-MAIN	U	YES		U		3	;U;67;N
92730	122432	LL	1556661	150427-MIDPOINT-MAIN	U	YES		U		5	;U;50;N
92730	122433	LL	1556661	150427-MIDPOINT-MAIN	U	YES		U		10	;U;0.50;N
92730	122433	LL	1556661	150427-MIDPOINT-MAIN	U	YES		U		12	;U;0.50;N

Figure 4. Validator Workbook Example

6. Post-Field Operations / Data Workflow

This section summarizes the data management activities and workflow primarily for tasks performed after the field work is complete. There may be some chronological overlap of some tasks described below with the field data collection effort. The loading and management of historical (existing) tabular and geospatial data is discussed here, as well as general geospatial data management tasks, and data export operations in support of final USACE / JBLM deliverables.

6.1 Existing Data Review

A limited amount of historical and existing data will need to be reviewed and configured for use on the project. This consists primarily of PFC-related analytical chemistry data from approximately 12 production wells, and the existing monitoring well locations. These monitoring well locations need to be added to Project Database in order to be able to load the new sampling results. The following subsections describe the data management activities relevant to this task.

6.1.1 Loading Tabular Historical Data to EQuIS

If available and relevant to PA/SI interpretations, historical PFC-related analytical chemistry data and production well locations can be loaded to the Project Database. The datasets are anticipated to be loaded primarily by the EDD approach described in Section 5, however, some assumptions and backfilling of data elements may be required. Similarly, existing monitoring well location names and coordinates will need to be loaded to the Project Database in order to subsequently load new sample and analytical chemistry results to be collected during the PA/SI. Location coordinate data can be extracted from maps, obtained as tabular records from JBLM well inventories, or re-surveyed by AECOM or BRH. Once the existing monitoring well data are loaded to the Project Database, subsequent sample and analytical chemistry data can be loaded following the conventional EDD approach described above.

6.1.2 Managing Historical Geospatial Data

As described in Section 4.2.1, historical geospatial data for the project consists of existing aerial imagery, base layers, and well locations provided to AECOM by JBLM and USACE. This geospatial data will be used “as is” but may be reviewed and organized for the purposes of PA/SI figure production. Historical monitoring well and production well point data may also be used “as is” for the purpose of figure production if the locations are not re-surveyed. Otherwise it is recommended that the existing monitoring well location map positions be validated and updated to improve positional accuracy.

6.2 Geospatial Data Management

The general process and procedures to be used by AECOM in geospatial data management are described on this section. These procedures pertain to data which is inherently geospatial and not a product of tabular exports joined to spatial features which are described in earlier sections of this document.

6.2.1 Geospatial Data Configuration

AECOM is using an ArcGIS v10.5.1 file geodatabase format to manage inherently geospatial datasets for the project. The master repository has standardized classifications / thematic content organization provided by JBLM or as developed by AECOM, including the following subject matter:

- Base Layers
    - Installation Boundary
    - Airfield Boundary/Lines
    - Roads
    - Buildings/Infrastructure
- Imagery (Aerial)
- Topography (0.5 m contours)
- Surface Water Features
- Well Inventories
- Well Head Protection
- Stormwater / Sanitary Sewer
- Environmental
    - Environmental Restoration (ER) Sites
    - Landfills
    - Potential Areas of Concern (PA/SI Investigation)
    - Sample Locations (Surface Water, New Monitoring Wells)
    - Capture Zones (for wells)

6.2.2 Geospatial Data Editing

Geospatial data editing operations will be at the discretion of a small group of GIS Analysts on the AECOM team. Basic rules of thumb proposed for geospatial editing operations are as follows:

- Only limited data editing will be performed on JBLM-provided datasets.

- Attributes within the feature classes shall be complete to the maximum extent possible, and free-form data fields should not repeat information captured in standard domain values.
- Any significant changes to geospatial data completed by AECOM will be documented in the metadata (see Section 4.4).
- AECOM will work collaboratively with JBLM / USACE when updating nomenclature, attribution, domain values or when making other decisions regarding standardization of geospatial content.

6.2.3 Derivative Geospatial Work Products

The scope and content of derivative geospatial work products has not been completely defined and is expected to evolve as historical (existing) data is reviewed, as new data is collected, and as data is interpreted as part of the reporting phase of the project. At this time the following basic requirements will be implemented for derivative geospatial work products which are defined as the output of GIS Analysis (interpolated contamination boundaries, volumetric calculations, concentration isopleths, mass loading calculations, etc.):

- Geospatial deliverables will be in an ArcGIS v10.5.1 file geodatabase format
- Work products will comply with geodetic and metadata requirements specified in Section 4
- Deliverable will consist of a stand-alone ESRI Map Package with the .MXD, layer file, and nested source data and directory structures
- New content which may be used as a source for other analyses, or which may stand alone as a geospatial dataset will be imported/ added to the master geospatial repository. Such content will be called out in any data transmittal.

6.3 Data Summarization Rules, Exports, and Final Deliverables

This section summarizes quantitative data summarization rules, methods for extracting historical and new data from the Project Database or geospatial repository, and the content and process associated with final project deliverables to JBLM and USACE.

6.3.1 Quantitative Data Summarization and Duplicate Rules

Analyte summations and other calculated analyte values will be stored as separate analyte concentrations in the Project Database. Deviations from this approach that may result from data review and analysis will be fully documented and reported in any project deliverables or data exports. All field duplicates, lab replicates, and parent samples will be loaded, clearly linked, and stored in the Project Database. Exports will clearly discriminate parent from duplicate and

replicate samples; calculations related to these samples may use maximum value, average, or include all sample values.

6.3.2 Extracting and Transmitting Data

It will be critical to distinguish datasets that are inherently tabular and stored in the Project Database from pure geospatial datasets, and to identify hybrid tabular/geospatial datasets created by joining tabular exports to geospatial point, line, or polygon data. For tabular exports, some basic specifications for the output and format are as follows:

- ASCII text flat files or Excel workbooks are specified.
- The first row in the file will contain the field names, which are to consist of uppercase letters, numbers, or underscores (i.e., no special characters).
- The first field/column in the file will be dedicated to the unique identifier (Location ID).
- Text qualifiers, such as single or double quotes, and other special characters will not be included in the content.
- Commas (,), pipes (|), or other suitable delimiters will be used for text file exports.
- The SQL statement used to extract the data will be included with the export.

6.3.3 USACE Data Submittal Standards

AECOM has received no technical direction or specific data submittal standards for JBLM tabular data transfer to USACE. Accordingly, AECOM intends to transmit tabular data using the EQuIS EQEDD format (.CSV or .TXT load format). Also, unless directed otherwise, AECOM only intends to transmit one final dataset after all QA/QC steps are complete for the package. Also, unless directed otherwise, AECOM intends to provide lithologic data and well completion information in a PDF / diagram format, and not in database / tabular format. Finally, photos and any scanned field forms or logbook notes would be provided in .JPG and .PDF format, respectively, organized into a standardized folder structure with agreed upon naming conventions.

6.3.4 USACE Geospatial Data Submittals

AECOM will submit geospatial deliverables in an ArcGIS v10.5.1 FGDB format, following the geodetic and metadata requirements specified in Section 4 of this document. In addition, the data will be submitted as a stand-alone ESRI Map Package with the .MXD file, the layer file, and nested source data and directory structures. Anticipated geospatial work products are expected to include feature classes including: Capture Zone, Potential Areas of Concern, new Monitoring

Well and Surface Water sampling locations, and other geospatial analysis feature classes developed during the interpretation and report writing phases of the project.

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7. References

AECOM 2018. Project-Specific Quality Assurance Project Plan, PFOS/PFOA Preliminary Assessment/Site Inspection, Joint Base Lewis-McChord, Washington. March.

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ATTACHMENT B-1

Tabular Data/EQuIS Specifications

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APPENDIX B-1

Project Database: EQuIS Specifications

EDD Name	EDD Description
Facility EDD	Facility, location and coordinate related data.
Geology EDD	Well, water level, geological sampling and lithology related data.
AECOM EDD 2.5.3	Field samples, laboratory samples and analytical results data.
LoadDVA EDD	Analytical data qualification and validation.
EQEDD EDD	For loading historical or transmitting data to USACE/JBLM.

Facility EDD:

Facility, location and coordinate related data.

Field Name	Data Type	Required	Comment
facility_code	Text(20)	Y	The user-defined code of a specific facility, for example, "Springfield".
prp_agency	Text(20)		The regulated agency which oversees the potential responsible party (PRP).
data_provider	Text(20)		The person responsible for providing data about the facility.
facility_type	Text(20)		The facility type, for example, "UST" for an Underground Storage Tank facility.
program_code	Text(20)		The state or federal regulated program which the facility falls under, for example, "RCRA" or "SUPERFUND".
facility_name	Text(60)		The common name for the facility.
address_1	Text(40)		Contains the street address of the facility.
address_2	Text(40)		Contains the second line of the street address of the facility.
city	Text(30)		The city where facility is located.
county	Text(50)		The county where the facility resides.
state	Text(10)		The state where the facility is located.
country	Text(50)		The country where the facility resides.
postal_code	Text(30)		The postal code where the facility resides.
coord_type_code	Text(20)		The facility-specific code which refers to a specific coordinate type, for example, "LATLONG" for a latitude/longitude coordinate system.
phone_number	Text(30)		The phone number pertaining to a specific facility.
alt_phone_number	Text(30)		The alternate or secondary phone number pertaining to a specific facility.
fax_number	Text(30)		The fax number pertaining to a specific facility.
email_address	Text(100)		The email address pertaining to a specific facility.
remark	Text(2000)		Any additional comments or remarks regarding the facility.
client	Text(50)		The client responsible for a specific facility.
identifier	Text(20)		The facility-specific coordinate identifier, for example, "PRIMARY".
sys_region_code	Text(20)		Regional identifier of a specific facility.
project_manager	Text(50)		The person responsible for managing a project which pertains to a specific facility.
start_date	DateTime		The date/time the faciilty was established.
coord_unit	Text(15)		The unit of measurement of the coordinate type.
elev_unit	Text(15)		The unit of measurement of the elevation of a facility.
x_min	Numeric		x_min
x_max	Numeric		x_max
y_min	Numeric		y_min
y_max	Numeric		y_max
z_min	Numeric		z_min
z_max	Numeric		z_max
custom_field_1	Text(255)		Custom field.
custom_field_2	Text(255)		Custom field.
custom_field_3	Text(255)		Custom field.
custom_field_4	Text(255)		Custom field.
custom_field_5	Text(255)		Custom field.

Field Name	Data Type	Required	Comment
facility_code	Text(20)	Y	The user-defined code of a specific facility, for example, "Springfield".
parameter_code	Text(40)	Y	Code used to identify parameter being measured, observed, or attribute being described
parameter_value	Text(255)		Value of parameter
parameter_unit	Text(15)		Parameter unit
measurement_date	DateTime		Date of parameter measurement or observation
measurement_method	Text(20)		Measurement method
task_code	Text(40)		Code used to identify the task under which the field sample was taken.
remark	Text(2000)		Remark

Field Name	Data Type	Required	Comment
facility_code	Text(20)	Y	The user-defined code of a specific facility, for example, "Springfield".
sys_loc_code	Text(20)	Y	Location identifier of sample collection, soil boring, or well installation. Examples of possible sys_loc_code are MW-01, A-1, SB6, etc.
loc_name	Text(40)		The descriptive name of a specific location.
data_provider	Text(20)		The company that provides the data for a specific location, with lookup values from RT_COMPANY.
subfacility_code	Text(20)		The identifying code that describes the subfacility where a specific location is located.
loc_desc	Text(255)		A general description of the location type.
loc_type	Text(20)		The type of specific location, for example "Monitoring Well", with lookup values from RT_LOCATION_TYPE.
loc_purpose	Text(20)		The purpose or reason the location was installed, for example "Quarterly Monitoring."
loc_type_2	Text(30)		A secondary field for the type of location.
loc_major_basin	Text(20)		The major geographical basin in which a location is located, with lookup values from RT_BASIN.
within_facility_yn	Text(1)		Denotes whether the location is located within the facility (Y) or not (N).
loc_county_code	Text(30)		The identifying code that describes the county in which a location is located.
loc_district_code	Text(20)		The identifying code that describes the district in which a location is located.
loc_state_code	Text(10)		The identifying code which describes the state in which a location is located.
loc_minor_basin	Text(20)		The minor or subbasin in which the location is located.
custom_field_1	Text(255)		Custom field.
stream_code	Text(30)		The identifying code that describes the stream nearest to a specific location, with lookup values from RT_STREAM.
custom_field_2	Text(255)		Custom field.
stream_mile	Numeric		This indicates where the river or stream (stream_code) for the station exists.
custom_field_3	Text(255)		Custom field.
custom_field_4	Text(255)		Custom field.
phase_code	Text(10)		The identifying code that describes the phase of remediation when the location was installed.
custom_field_5	Text(255)		Custom field.
remark_1	Text(2000)		Any additional remarks regarding a specific location.
bore_id	Text(30)		The identifier of the drilled borehole.
remark_2	Text(2000)		Any additional remarks regarding a specific location.
start_date	DateTime		The date that location installation began.
end_date	DateTime		The date the location installation was completed.
drilling_method	Text(40)		The method used to drill a specific location, for example "Rotary."
geologist	Text(50)		The name of the geologist responsible for logging a specific location.
sampling_method	Text(30)		The method of sampling used during the installation of a specific location.
drawing_checker	Text(50)		drawing_checker
drawing_check_date	DateTime		The date that the draw at a specific location is checked for accuracy.
drawing_editor	Text(50)		drawing_editor
drawing_edit_date	DateTime		drawing_edit_date
driller	Text(50)		The name of the person that performed the drilling at a specific location.
units	Text(15)		units
depth_to_bedrock	Numeric		The measured depth to bedrock at a specific location.
log_date	DateTime		The date the location was logged.
total_depth	Numeric		The total measured depth of the location.
bearing	Text(20)		Gives the angle between a line connecting two points and a north-south line, or meridian. This field can be populated by the bearing column in the Orientation file in RockWorks import format.
approved	Text(1)		Denotes whether a location was approved for installation (Y) or not (N) by a manager.
plunge	Text(20)		Measurement of the lineation/fold axis (measured from horizontal) in degrees.
drilling_subcontractor	Text(20)		The company or subcontractor that performs the drilling at a specific location.
engineer_subcontractor	Text(20)		The engineering company or subcontractor responsible for location installation.
engineer	Text(50)		The name of the engineer responsible for the installation of a location.
estab_company_code	Text(20)		Code of the established company at a location.
excav_company_code	Text(20)		The identifier code for the name of the company that performed the excavations at a specific location.
inspector	Text(50)		The name of the person responsible for inspecting a specific location.
inspect_subcontractor	Text(20)		The company or subcontractor that is responsible for the inspection of a specific location.
map_code	Text(128)		The identifying code that describes the USGS (or other) map where a specific location is located.
parent_loc_code	Text(20)		Parent location code.

Field Name	Data Type	Required	Comment
facility_code	Text(20)	Y	The user-defined code of a specific facility, for example, "Springfield".
sys_loc_code	Text(20)	Y	Location identifier of sample collection, soil boring, or well installation. Examples of possible sys_loc_code are MW-01, A-1, SB6, etc.
coord_type_code	Text(20)	Y	The location-specific code which refers to a specific coordinate type, for example, "LATLONG" for a latitude/longitude coordinate system.
observation_date	DateTime		The date/time when the coordinates were measured.
identifier	Text(20)	Y	The identifier (e.g. 1 or PRIMARY) used to designate when a coordinate system should be used.
x_coord	Text(20)		The x-coordinate in a coordinate system.
y_coord	Text(20)		The y-coordinate in a coordinate system.
elev	Text(20)		The measured elevation of a specific location.
elev_unit	Text(15)		The unit of measurement for the elevation measurement.
horz_collect_method_code	Text(20)		The code which identifies the method used to measure the horizontal coordinates, populated from RT_COORD.HORZ_METHOD.
coord_zone	Text(15)		The zone associated with a coordinate system, such as UTM zone 17.
horz_accuracy_value	Text(20)		The accuracy to which the horizontal (x and y) coordinates are measured.
horz_accuracy_unit	Text(15)		The unit of measurement for the horizontal (x and y) coordinate accuracy.
elev_accuracy_unit	Text(15)		The unit of measurement for the elevation accuracy measurement.
horz_datum_code	Text(20)		A code that describes the datum (reference point) against which horizontal measurements are made, populated from RT_COORD.HORZ_DATUM.
elev_collect_method_code	Text(20)		The code which identifies the method used to measure the elevation, populated from RT_CODE.ELEV_METHOD.
elev_accuracy_value	Text(20)		The accuracy to which the elevation is measured.
elev_datum_code	Text(20)		The code that describes the reference point against which elevation measurements are made.
source_scale	Text(20)		The scale of a source.
company_code	Text(20)		The identifier of the company collecting the respective coordinates.
verification_code	Text(20)		The verification code of the coordinate system.
data_point_sequence	Text(20)		Number indicating the sequence in which points on a line or area are connected. MAD Code Opt#8.
reference_point	Text(50)		The point of reference from where a coordinate was collected.
geometric_type_code	Text(20)		The code that represents the geometric entity represented by one point or a sequence of latitude and longitude points.
surveyor_name	Text(255)		The name of the surveyor who took the coordinate readings.
rank	Numeric		Ranks the coordinates as 1 (a vector quantity with one direction) or 2 (a vector quantity with multiple directions).
remark	Text(2000)		Any additional remarks or comments pertaining to a location's coordinates.

Field Name	Data Type	Required	Comment
group_code	Text(40)	Y	group_code
group_type	Text(30)	Y	The type of group used by fn_group_members to compute group members. Possible values are: * or sys_loc_code.
group_desc	Text(255)		Description of a particular group.
group_owner	Text(50)		Person that created the group.
group_date	DateTime		Group creation date.
remark	Text(2000)		Any additional remarks or comments pertaining to the group.
facility_code	Text(20)		The user-defined code of a specific facility, for example, "Springfield".

Field Name	Data Type	Required	Comment
member_code	Text(60)	Y	member_code
group_code	Text(40)	Y	group_code
member_type	Text(30)	Y	Member type must reflect the type of object referenced by member_code. Valid values are strongly dependent on feature implementation, please consult the documentation for the report or module for more information.
report_order	Numeric		Sort order for hardcopy reports.
display_order	Numeric		Display order for screen forms.
remark	Text(2000)		Any additional remarks or comments pertaining to the group member.
facility_code	Text(20)		The user-defined code of a specific facility, for example, "Springfield".

Geology EDD:

Well, water level, geological sampling and lithology related data.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier
data_provider	Text(40)		Location data provider
x_coord	Numeric		X coordinate/Easting
y_coord	Numeric		Y coordinate/Northing
surf_elev	Numeric		Surface elevation value
elev_unit	Text(15)		Surface elevation unit
total_depth	Numeric		Total depth associated with location
depth_to_bedrock	Numeric		Depth to bedrock
units	Text(15)		Depth units
bearing	Text(20)		Angle of variance from a given reference point (i.e. North)
plunge	Text(20)		Angle of variance (inclination) from horizontal
loc_name	Text(40)		Location name
loc_desc	Text(255)		Location description
loc_type	Text(20)		Location type 1
loc_type_2	Text(30)		Location type 2
loc_purpose	Text(50)		Location purpose
site_code	Text(20)		Code used to specify site for location
coord_type_code	Text(20)		Code representing coordinate system in which x_coord and y_coord are expressed
start_date	DateTime		Date started at location
end_date	DateTime		Date ended at location
log_date	DateTime		Date log entry made
survey_date	DateTime		Date survey was done.
surveyor_name	Text(255)		Name of surveyor
driller	Text(50)		Name of driller
drilling_subcontractor	Text(40)		Code of drilling subcontractor
drilling_method	Text(40)		Simple description of drilling method
geologist	Text(50)		Name of geologist
engineer	Text(50)		Name of engineer
engineer_subcontractor	Text(40)		Engineering subcontractor
inspector	Text(50)		Name of inspector
inspect_contractor	Text(40)		Code of drilling subcontractor
drawing_checker	Text(50)		Name of person checking the drawing
drawing_check_date	DateTime		Date drawing was checked
drawing_editor	Text(50)		Name of person editing the drawing
drawing_edit_date	DateTime		Date edit to drawing was made.
within_facility_yn	Text(1)		Yes/No value indicating if location is within facility.
loc_county_code	Text(30)		Location county code
loc_district_code	Text(20)		Location district code
loc_state_code	Text(10)		Location state code
loc_major_basin	Text(20)		Location major basin
loc_minor_basin	Text(20)		Location minor basin
phase_code	Text(10)		Location phase code
estab_company_code	Text(40)		Location establishing company code
excav_company_code	Text(40)		Location excavation company code
remark	Text(2000)		Remark 1

Field Name	Data Type	Required	Comment
remark_2	Text(2000)		Remark 2
approved	Text(1)		Approved
stream_code	Text(30)		Stream code
stream_mile	Numeric		Stream mile
custom_field_1	Text(255)		Custom field 1
custom_field_2	Text(255)		Custom field 2
custom_field_3	Text(255)		Custom field 3
custom_field_4	Text(255)		Custom field 4
custom_field_5	Text(255)		Custom field 5
identifier	Text(20)		Text identifier that facilitates unique representation of the coordinate system.

Field Name	Data Type	Required	Comment
site_code	Text(20)	Y	Unique site identifier.
site_type	Text(20)		Site type.
site_name	Text(60)		Site name.
site_task_code	Text(40)		Site task code.
site_desc1	Text(2000)		Site description1.
site_desc2	Text(2000)		Site description2.
contact_name	Text(50)		Name of contact for site.
address1	Text(40)		Site address 1.
address2	Text(40)		Site address 2.
city	Text(30)		City.
state	Text(10)		State abbreviation.
zipcode	Text(230)		Zipcode
phone_number	Text(30)		Phone number of site.
alt_phone_number	Text(30)		Alternate Phone number.
fax_number	Text(30)		Fax number.
email_address	Text(100)		Email address of site contact.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
well_id	Text(30)		Non-unique well identifier, name, or alias.
well_owner	Text(50)		Owner of well
well_purpose	Text(20)		Brief description of well use (i.e. 'Monitoring', 'Injection', 'Extraction', 'Water Supply', etc.)
well_status	Text(20)		Current status of well.
top_casing_elev	Numeric		Elevation of the top of well casing.
depth_of_well	Numeric		Total depth of the well as measured from a specified measuring point at construction.
depth_unit	Text(15)		Unit of measure for well depth.
depth_measure_method	Text(20)		Method used to make the well depth measurement.
stickup_height	Text(8)		Total height which well extends about ground surface.
stickup_unit	Text(15)		Unit of measure for stickup height.
sump_length	Text(20)		Length of sump at well installation.
sump_unit	Text(15)		Unit of measure for sump length.
installation_date	DateTime		Date well was installed.
construct_start_date	DateTime		Date well construction began, if different from installation date.
construct_complete_date	DateTime		Date well construction was completed, if different from installation date.
construct_contractor	Text(40)		Name of company that installed well.
pump_type	Text(20)		Type of pump installed, if applicable.
pump_capacity	Text(6)		Pump capacity.
pump_unit	Text(15)		Unit of measure for pump capacity (i.e. gal/minute).
pump_yield	Text(6)		Pump yield
pump_yield_method	Text(20)		Method of testing pump yield.
weep_hole	Text(1)		Does well have weep hole (Y/N)?
head_configuration	Text(50)		Description of well head configuration.
access_port_yn	Text(1)		Does well have access port (Y/N)?
casing_joint_type	Text(50)		Description of well casing joint type.
perforator_used	Text(50)		Description of well perforator, if applicable.
intake_depth	Numeric		Depth of well intake.
disinfected_yn	Text(1)		Has well been disinfected (Y/N)?
historical_reference_elev	Numeric		Elevation of reference measuring point.
geologic_unit_code	Text(20)		Geologic unit which well samples from.
geologist_name	Text(50)		Geologist name.
driller	Text(50)		Driller
custom_field_1	Text(255)		Custom field 1.
custom_field_2	Text(255)		Custom field 2.
custom_field_3	Text(255)		Custom field 3.
custom_field_4	Text(255)		Custom field 4.
custom_field_5	Text(255)		Custom field 5.
remark	Text(2000)		Remark.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
site_code	Text(20)	Y	Unique site identifier.
site_loc_type_code	Text(10)		Code indicating whether the location is onsite, offsite or background.
gradient	Text(20)		Gradient

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
param_code	Text(20)	Y	Code used to identify parameter being measured.
param_value	Text(255)		Value of parameter.
param_unit	Text(15)		Unit of parameter measurement.
measurement_method	Text(20)		Method used to measure parameter.
measurement_date	DateTime		Date of measure parameter.
remark	Text(2000)		Remarks about parameter.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
coord_type_code	Text(20)	Y	Unique identifier describing coordinate system in which this location is referenced.
identifier	Text(20)	Y	Text identifier that facilitates unique representation of the coordinate system.
observation_date	DateTime		Date when position observation was made.
alt_x_coord	Text(20)		Alternate x coordinate.
alt_y_coord	Text(20)		Alternate y coordinate.
elev	Text(20)		Alternate elevation.
elev_unit	Text(15)		Unit of measurement for the elevation.
horz_collect_method_code	Text(20)		Code that represents the method used to determine the coordinates for a point on the earth.
horz_accuracy_value	Text(20)		Measure of the accuracy of the x, y coordinates.
horz_accuracy_unit	Text(15)		Unit of measure used to quantify the measure of horizontal accuracy.
horz_datum_code	Text(20)		Code that represents the reference datum used in determining x, y coordinates.
elev_collect_method_code	Text(20)		Code that represents the method used to collect the vertical measure or elevation of a reference point.
elev_accuracy_value	Text(20)		Measure of accuracy of the elevation.
elev_accuracy_unit	Text(15)		Unit of measure used to quantify the measure of vertical or elevation accuracy.
elev_datum_code	Text(20)		Code that represents the reference datum used to determine the vertical measure or elevation.
source_scale	Text(20)		Represents the proportional distance on the ground for one unit of measure on a map or photo.
subcontractor_name_code	Text(40)		Code used to represent the subcontractor or party responsible for providing coordinate information.
verification_code	Text(20)		Code that represents the process used to verify the coordinate information.
reference_point	Text(50)		Text that identifies the place for which geographic coordinates were established.
geometric_type_code	Text(20)		Code that defines the geometric entity represented. As sys_loc_code typically defines a location (borehole, well, etc.) this will likely be 'point'.
remark	Text(2000)		remark.
rank	Numeric		Integer that represents preference where more than one coordinate system exists for a given sys_loc_code.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
depth	Numeric	Y	Depth at which parameter was observed or measured.
param	Text(20)	Y	Parameter observed or measured at this point.
param_value	Text(255)		Value observed or measured at this point for this parameter.
param_unit	Text(15)		Unit of measurement for parameter value.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
drill_event	Text(20)	Y	Used to uniquely identify a drilling event.
start_depth	Numeric	Y	Start depth of drill activity.
end_depth	Numeric	Y	End depth of drill activity.
start_date	DateTime		Date drilling activity started.
end_date	DateTime		Date drilling activity was completed.
diameter	Text(20)		Diameter of drilled hole.
diameter_unit	Text(15)		Unit of measurement for diameter of drilled hole.
drill_method	Text(50)		Method of drilling/advancement.
casing_size	Text(50)		Size of casing installed. Note that this is a general text field and non-numeric entries such as "Schedule 40" are permitted.
rig_desc	Text(50)		Description of drilling rig.
rig_make	Text(50)		Drilling rig make.
rig_model	Text(50)		Drilling rig model.
rod_desc	Text(50)		Description of drilling rod.
bit_desc	Text(50)		Description of drilling bit.
hammer_desc	Text(50)		Description of hammer.
auger_desc	Text(50)		Description of auger.
sampler_desc	Text(50)		Description of sampler.
fluid	Text(50)		Drilling fluid used.
viscosity	Text(50)		Viscosity of drilling fluid.
drilling_pressure	Text(50)		Drilling pressure.
hammer_wt	Text(50)		Weight of hammer.
hammer_fall	Text(50)		Fall length of hammer.
lift_mechanism	Text(50)		Mechanism used to lift hammer.
new_yn	Text(1)		Is this a new borehole (Y or N)?
repair_yn	Text(1)		Is this drilling activity to repair an existing borehole (Y or N)?
deepen_yn	Text(1)		Is this drilling activity to deepen an existing borehole (Y or N)?
abandon_yn	Text(1)		Is this drilling activity to abandon an existing borehole (Y or N)?
replace_yn	Text(1)		Does this drilling activity replace another borehole (Y or N)?
public_yn	Text(1)		Is this borehole owned or used by a public agency (Y or N)?
purpose	Text(70)		Purpose of drilling activity.
remark	Text(2000)		Drilling activity remark.
custom_field_1	Text(255)		Custom field 1.
custom_field_2	Text(255)		Custom field 2.
custom_field_3	Text(255)		Custom field 3.
custom_field_4	Text(255)		Custom field 4.
custom_field_5	Text(255)		Custom field 5.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
drill_event	Text(20)	Y	Used to uniquely identify a drilling event.
start_depth	Numeric	Y	Start depth of drill activity.
param_code	Text(20)	Y	Parameter observed or measured over this interval.
end_depth	Numeric		End depth of drill activity.
run_length	Text(20)	Y	Length of drilling run.
param_value	Text(255)		Value observed or measured over this interval for this parameter.
param_unit	Text(15)		Unit of measurement for parameter value.
remark	Text(2000)		Drilling activity remark.

Field Name	Data Type	Required	Comment
geo_sample_code	Text(40)	Y	Unique sample identifier.
sample_name	Text(50)		Optional, non-unique sample identifier.
sys_loc_code	Text(20)		Unique location identifier.
sample_top	Numeric		Top (depth) of geologic sample.
sample_bottom	Numeric		Bottom (depth) of geologic sample.
sampling_date	DateTime		Date (and time, if appropriate) of sampling.
matrix_code	Text(10)		Geologic matrix or sample type
sample_method	Text(40)		Method used for sample collection.
sample_desc	Text(255)		Free text description of geologic sample.
custom_field_1	Text(255)		Custom field 1.
custom_field_2	Text(255)		Custom field 2.
custom_field_3	Text(255)		Custom field 3.
custom_field_4	Text(255)		Custom field 4.
custom_field_5	Text(255)		Custom field 5.
sample_type_code	Text(20)	Y	Code which distinguishes between different types of samples. For example, normal field samples must be distinguished from laboratory method blank samples, etc.
depth_unit	Text(15)		Unit of measurement for the sample begin and end depths

Field Name	Data Type	Required	Comment
geo_sample_code	Text(40)	Y	Unique sample identifier.
liquid_limit	Text(10)		Soil moisture content at the point of transition from plastic to liquid state.
plastic_limit	Text(10)		Soil moisture content at the point of transition from semisolid to plastic state, the point at which soil crumbles when rolled into threads of 1/8" diameter.
shrinkage_limit	Text(10)		Soil moisture content at the point of transition from solid to semisolid state, or the point at which the volume of soil mass ceases to change with continuing loss of moisture.
flow_index	Text(10)		Slope of the flow line, where the flow line is the relationship between moisture content and log N, N being the number of blows in a Liquid Limit test.
plasticity_index	Text(10)		Difference between the liquid limit and the plastic limit (LL-PL).
liquidity_index	Text(10)		Ratio of in situ moisture content – plastic limit to plasticity index, (wn-PL) / (LL-PL).
activity	Text(10)		Slope of line correlating PI and % finer than 2 μm.
atterberg_moisture	Text(10)		Arbitrary moisture content for sample defined by sys_sample_code.

Field Name	Data Type	Required	Comment
geo_sample_code	Text(40)	Y	Unique sample identifier.
param_code	Text(20)	Y	Parameter observed during acquisition of this sample (i.e. N1, N2, N3, N4, PID, FID, OVM, Length Advanced, Length Recovered, Tip Stress, etc.)
param_value	Text(255)		Value observed or measured for this parameter.
param_unit	Text(15)		Unit of measurement for parameter value, if applicable.
measurement_method	Text(20)		Method of measurement for this parameter, if applicable.
remark	Text(2000)		Remark.
measurement_date	DateTime		measurement date.

Field Name	Data Type	Required	Comment
geo_sample_code	Text(40)	Y	Unique sample identifier.
sample_desc	Text(255)		Sample description.
material_name	Text(40)		Material name.
geologic_unit_code	Text(20)		Geologic unit code.
e	Numeric		Void ratio.
e_max	Numeric		Maximum void ratio.
e_min	Numeric		Minimum void ratio.
n	Numeric		Porosity.
specific_gravity	Numeric		Specific gravity.
w	Numeric		Moisture content.
opt_w	Numeric		Optimum moisture content.
S	Numeric		Saturation.
K	Numeric		Hydraulic conductivity.
K_unit	Text(15)		Unit of measurement for hydraulic conductivity.
unit_wt	Numeric		Unit weight.
sat_unit_wt	Numeric		Saturated unit weight.
dry_unit_wt	Numeric		Dry unit weight.
dry_unit_wt_max	Numeric		Maximum dry unit weight.
dry_unit_wt_min	Numeric		Minimum dry unit weight.
density_unit	Text(15)		Unit of measure for density (unit weight).
rel_density	Numeric		Relative density.
rel_compaction	Numeric		Relative compaction.
consistency	Text(20)		Consistency.
organic_carbon	Numeric		Organic carbon content.
organic_carbon_unit	Text(15)		Unit of measure for organic carbon.
custom_field_1	Text(255)		Custom field 1.
custom_field_2	Text(255)		Custom field 2.
custom_field_3	Text(255)		Custom field 3.
custom_field_4	Text(255)		Custom field 4.
custom_field_5	Text(255)		Custom field 5.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
start_depth	Numeric	Y	Start depth of lithology layer.
bearing	Numeric		Bearing, may be used for non-verticle boreholes
plunge	Numeric		plunge, may be used for non-verticle boreholes
material_type	Text(40)		Code used to specify material type.
geo_unit_code_1	Text(20)		Code used to specify geologic unit.
geo_unit_code_2	Text(20)		Code used to specify geologic unit.
geo_unit_code_3	Text(20)		Code used to specify geologic unit.
geo_unit_code_4	Text(20)		Code used to specify geologic unit.
geo_unit_code_5	Text(20)		Code used to specify geologic unit.
remark_1	Text(2000)		Lithologic layer remark 1.
remark_2	Text(2000)		Lithologic layer remark 2.
moisture	Text(20)		Qualitative description of soil moisture.
permeable	Text(20)		Indicator of permeability
consolidated_yn	Text(1)		Is layer consolidated (Y or N)?
cementation	Text(20)		Qualitative description of cementation.
color	Text(30)		Layer color.
observation	Text(255)		General layer observation.
consistency	Text(20)		Soil consistency.
sorting	Text(20)		Descriptor of soil particle size sorting.
grainsize	Text(20)		Measure of particle size.
odor	Text(20)		Soil odor.
angularity	Text(20)		Angularity of soil particles.
custom_field_1	Text(255)		Custom field 1.
custom_field_2	Text(255)		Custom field 2.
custom_field_3	Text(255)		Custom field 3.
custom_field_4	Text(255)		Custom field 4.
custom_field_5	Text(255)		Custom field 5.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
measurement_date	DateTime	Y	Date and time of measurement.
historical_reference_elev	Numeric		Elevation of reference measuring point.
water_level_depth	Numeric		Depth of water level.
water_level_elev	Numeric		Elevation of water level.
corrected_depth	Numeric		Depth of water level, corrected, for example, for free product.
corrected_elevation	Numeric		Elevation of water level, corrected, for example, for free product.
measured_depth_of_well	Numeric		Depth of well as measured at the time of this water level measurement.
depth_unit	Text(15)		Unit of measure for water level depth, corrected depth, and measured depth of well.
technician	Text(50)		Name of technician taking measurements.
dry_indicator_yn	Text(1)		Is well dry (Y/N)?
measurement_method	Text(20)		Method used to make the well depth measurement.
dip_or_elevation	Text(10)		Enforced vocabulary ('dip', 'elevation').
batch_number	Text(10)		Batch, or grouping number, for water level measurement.
remark	Text(2000)		Remark.
lnapl_depth	Numeric		LNAPL depth
lnapl_cas_rn	Text(15)		LNAPL CAS number
dnapl_depth	Numeric		DNAPL depth
dnapl_cas_rn	Text(15)		DNAPL CAS number
task_code	Text(40)		Task code
equipment_code	Text(60)		Equipment code
reportable_yn	Text(1)	Y	reportable_yn

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
type	Text(20)	Y	Designation of aquifer. Can be general such as “Unconfined” or “Confined”, or a specific aquifer name such as “Ogalalla”.
sequence	Text(20)	Y	Sequence in which this measurement was taken. Intended to represent 1 of 2 mutually exclusive values, i.e. Unstabilized/Stabilized, or Initial/Final, or 1/2, etc.
depth	Numeric	Y	Depth of water table.
flowing_yn	Text(1)		Is water flowing from drill hole (Y/N)?
measurement_method	Text(50)		Method used to obtain water table measurement.
capped_pressure	Numeric		Water pressure when capped.
capped_pressure_unit	Text(15)		Unit of measure for water pressure when capped.
reference_point	Text(50)		Point of reference for water table measurement.
reference_elevation	Numeric		Elevation of reference point for water table measurement.
temperature	Numeric		Water temperature.
temperature_unit	Text(15)		Unit of measure for water temperature.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
segment_type	Text(20)	Y	Type of segment described in this record.
material_type_code	Text(20)	Y	Material used for construction of this well.
start_depth	Numeric	Y	Start depth of well segment.
end_depth	Numeric		End depth of well segment.
depth_unit	Text(15)		Unit of measure for well segment start depth and end depth.
inner_diameter	Numeric	Y	Inner diameter of well segment.
outer_diameter	Numeric		Outer diameter of well segment.
diameter_unit	Text(15)		Unit of measure for inner and outer diameters.
thickness	Numeric		Thickness of well segment.
thickness_unit	Text(15)		Unit of measure for thickness.
slot_type	Text(20)		For screen segments, indicates type of screen slot.
slot_size	Numeric		For screen segments, indicates size of screen slot.
slot_size_unit	Text(15)		Unit of measure for slot size where segment_type is Screen.
perf_length	Numeric		Total perforated length for Screen segment types.
screen_type	Text(15)		Type of screen.
material_quantity	Text(20)		Quantity of fill material where applicable (annulus or grouted annulus segment types).
material_density	Text(20)		Density of fill material where applicable (annulus or grouted annulus segment types).
remark	Text(2000)		Remark.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique location identifier.
start_date	DateTime	Y	Date started.
step_or_linear	Text(6)	Y	Indicates whether the change in well datum was step or linear.
datum_value	Numeric	Y	Elevation of measuring reference point from which water level readings were taken.
datum_unit	Text(15)	Y	Unit of measure for well datum.
datum_desc	Text(255)	Y	Description of well datum.
datum_collect_method_code	Text(20)		Code representing method used to measure well daturm.

AECOM EDD 2.5.3.:

Field samples, laboratory samples and analytical results data.

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40); PK	Y	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. Sample IDs for field samples must be reported exactly as found on the chain of custody form, and may not be changed for subsequent tests (dilution, re-analysis, leachate, etc.)
sample_name	Text(50)		Additional sample identification information as necessary. Is not required to be unique (i.e., duplicates are OK).
sample_matrix_code	Text(10)	Y	Code which distinguishes between different type of sample matrix. For example, soil samples must be distinguished from ground water samples, etc. The matrix of the sample as analyzed may be different from the matrix of the sample as retrieved (e.g. leachates), so this field is required at both the sample and test level. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
sample_type_code	Text(10)	Y	Code which distinguishes between different types of samples. For example, normal field samples must be distinguished from laboratory method blank samples, etc. I Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
sample_source	Text(10)	Y	"Field" for field samples or "Lab" for internally generated lab QC samples No other values are allowed.
parent_sample_code	Text(40)		The value of "sys_sample_code" that uniquely identifies the sample that was the source of this sample. For example, the value of this field for a duplicate sample would identify the normal sample of which this sample is a duplicate. Required in the laboratory EDD for all laboratory "clone" samples (e.g., spikes and duplicates). Must be blank for samples which have no parent (e.g., normal field samples, LCS samples, method blanks, etc.).
sample_delivery_group	Text(20)		Sample delivery group as defined by AECOM project manager. Required for all field samples, optional for samples originating in the laboratory.
sample_date	Date		Date sample was collected in the field or sample was originated in the lab. Date information must be identical with the date from the chain of custody form.
sample_time	Time		Time sample was collected in the field or sample was originated in the lab. Time information must be identical with the date from the chain of custody form.
sys_loc_code	Text(20)		Sample collection location.

Field Name	Data Type	Required	Comment
start_depth	Numeric		Beginning depth (top) of soil sample. This is an optional field for the laboratory EDD unless otherwise specified by the AECOM project manager.
end_depth	Numeric		Ending depth (bottom) of soil sample. This is an optional field for the laboratory EDD unless otherwise specified by the AECOM project manager.
depth_unit	Text(15)		Unit of measurement for the sample begin and end depths. This is an optional field for the laboratory EDD unless otherwise specified by the AECOM project manager. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
chain_of_custody	Text(40)		Chain of custody identifier. A single sample may be assigned to only one chain of custody. This is an optional field for laboratory EDD unless otherwise specified by the AECOM project manager.
sent_to_lab_date	Date		Date sample was sent to lab (in MM/DD/YY format for EDD).
sample_receipt_date	Date		Date that sample was received at laboratory (in MM/DD/YY format for EDD).
sampler	Text(50)		Name or initials of sampler.
sampling_company_code	Text(20)		Name or initials of sampling company (no controlled vocabulary).
sampling_reason	Text(30)		Optional reason for sampling. No controlled vocabulary is enforced.
sampling_technique	Text(40)		Sampling technique. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
task_code	Text(40)		Code used to identify the task under which the field sample was retrieved. This is an optional field for laboratory EDD unless otherwise specified by the Chem project manager.
collection_quarter	Text(6)		Quarter of the year sample was collected (e.g., "1Q96").
composite_yn	Text(1)		Used to indicate whether a sample is a composite sample. "Y" for composite, "N" for not composite.
composite_desc	Text(255)		Description of composite sample (if composite_yn is "Y").
sample_class	Text(10)		Sample class code. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
custom_field_1	Text(255)		Custom sample field.
custom_field_2	Text(255)		Custom sample field.
custom_field_3	Text(255)		Custom sample field.
comment	Text(255)		Sample comments as necessary (optional).
sample_receipt_time	Time		Time of lab receipt sample in 24-hr (military) HH:MM format

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40); PK	Y	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. Sample IDs for field samples must be reported exactly as found on the chain of custody form, and may not be changed for subsequent tests (dilution, re-analysis, leachate, etc.)
sample_type_code	Text(20)	Y	Code which distinguishes between different types of samples. For example, normal field samples must be distinguished from laboratory method blank samples, etc. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
sample_matrix_code	Text(10)	Y	Code which distinguishes between different type of sample matrix. For example, soil samples must be distinguished from ground water samples, etc. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD. The matrix of the sample as analyzed may be different from the matrix of the sample as retrieved (e.g. leachates), so this field is required at both the sample and test level.
sample_source	Text(10)	Y	"Field" for field samples or "Lab" for internally generated lab QC samples No other values are allowed.
parent_sample_code	Text(40)		The value of "sys_sample_code" that uniquely identifies the sample that was the source of this sample. For example, the value of this field for a duplicate sample would identify the normal sample of which this sample is a duplicate. Required in the laboratory EDD for all laboratory "clone" samples (e.g., spikes and duplicates). Field duplicates may be submitted blind to the laboratory, so this field is not required in the laboratory EDD for field "clones". Must be blank for samples which have no parent (e.g., normal field samples, LCS samples, method blanks, etc.).
comment	Text(255)		Sample comments as necessary (optional).
sample_date	Date		Date sample was collected in the field or sample was originated in the lab. Date information must be identical with the date from the chain of custody form.
sample_time	Time		Time sample was collected in the field or sample was originated in the lab. Time information must be identical with the date from the chain of custody form.
sample_receipt_date	Date		Date that field sample was received at laboratory (in MM/DD/YY format for EDD).
sample_delivery_group	Text(20)		Sample delivery group as defined by AECOM project manager. Required for all field samples, optional for samples originating in the laboratory
standard_solution_source	Text(20)		Relevant only for lab-generated samples. Description of the source of standard solutions for certain laboratory samples (e.g., LCS).
sample_receipt_time	Time		Time of lab receipt sample in 24-hr (military) HH:MM format.

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40); PK	Y	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. Sample IDs for field samples must be reported exactly as found on the chain of custody form, and may not be changed for subsequent tests (dilution, re-analysis, leachate, etc.)
lab_anl_method_name	Text(20); PK	Y	Laboratory analytic method name or description. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD. The method name should be sufficient to reflect operation of the laboratory.
analysis_date	Date; PK	Y	Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by AECOM project manager.
analysis_time	Time; PK	Y	Time of sample analysis in 24-hr (military) HH:MM format. Time zone and daylight savings must be same as analysis_date.
total_or_dissolved	Text(10); PK	Y	Sample fraction tested. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
column_number	Text(2); PK	Y	Either "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses for which neither "1C" nor "2C" is applicable. If any "2C" tests are reported, then there must be corresponding "1C" tests present also. Also, laboratories typically can report which of the two columns is to be considered "primary". This distinction is handled by the "reportable_result" field in the result table.
test_type	Text(10); PK	Y	Type of test in the laboratory. This field is used to distinguish between initial runs, re-extractions, reanalysis and dilutions. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
lab_matrix_code	Text(10)		Code which describes the matrix as analyzed by the lab. May differ from sample_matrix_code. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
analysis_location	Text(2)	Y	Note where was sample analyzed. "FL" for mobile Field Laboratory analysis, "LB" for fixed_Based Laboratory analysis or "FI" for Field Instrument.
basis	Text(10)	Y	Must be either "Wet" for wet weight basis reporting, "Dry" for dry weight basis reporting, or "NA" for tests for which this distinction is not applicable.

Field Name	Data Type	Required	Comment
container_id	Text(30)		Sample container identifier.
dilution_factor	Numeric	Y	Dilution factor at which the analyte was measured effectively. Enter "1" if not diluted.
lab_prep_method_name	Text(20)		Laboratory sample preparation method code. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD. If preparation is part of the analytic method, use the code "METHOD".
prep_date	Date		Date sample preparation began in MM/DD/YYYY format.
prep_time	Time		Time sample preparation began in 24-hr (military) format. Time zone and daylight savings must be same as analysis_date.
leachate_method	Text(15)		Laboratory leachate generation method name or description. The method name should be sufficient to reflect operation of the laboratory. Required for tests on leachate (TCLP, SPLP, etc.)
leachate_date	Date		Date of leachate preparation in MM/DD/YYYY format. Required for tests on leachate (TCLP, SPLP, etc.)
leachate_time	Time		Time of leachate preparation in 24-hr (military) format. Time zone and daylight savings must be same as analysis_date. Required for tests on leachate (TCLP, SPLP, etc.)
lab_name_code	Text(20)	Y	Unique identifier of the laboratory. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
qc_level	Text(10)		Quality control level of analysis. May be either "screen" or "quant" (definitive).
lab_sample_id	Text(20)	Y	Laboratory LIMS sample identifier. If necessary, a field sample may have more than one LIMS lab_sample_id (maximum one per each test event).
percent_moisture	Numeric		Percent moisture of the sample portion used in this test; this value may vary from test to test for any sample. Report 70.1% as 70.1 not as 70.1%. Required for tests on solid matrices (soil, sediment, etc.)
subsample_amount	Text(14)		Amount of sample used for test. Required for tests on field samples.
subsample_amount_unit	Text(15)		Unit of measurement for subsample amount. Required when reporting subsample_amount. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
analyst_name	Text(50)		Name or initials of laboratory analyst.
instrument_id	Text(60)		Instrument identifier.
comment	Text(255)		Comments about the test as necessary.

Field Name	Data Type	Required	Comment
preservative	Text(20)		Sample preservative used. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
final_volume	Text(15)		The final volume of the sample after sample preparation. Include all dilution factors.
final_volume_unit	Text(15)		The unit of measure that corresponds to the final_volume. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40); PK	Y	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. Sample IDs for field samples must be reported exactly as found on the chain of custody form, and may not be changed for subsequent tests (dilution, re-analysis, leachate, etc.)
lab_anl_method_name	Text(20); PK	Y	Laboratory analytic method name or description. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD. The method name should be sufficient to reflect operation of the laboratory.
analysis_date	Date; PK	Y	Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by AECOM project manager.
analysis_time	Time; PK	Y	Time of sample analysis in 24-hr (military) HH:MM format. Time zone and daylight savings must be same as analysis_date.
total_or_dissolved	Text(10); PK	Y	Sample fraction tested. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
column_number	Text(2); PK	Y	Either "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses for which neither "1C" nor "2C" is applicable. If any "2C" tests are reported, then there must be corresponding "1C" tests present also. Also, laboratories typically can report which of the two columns is to be considered "primary". This distinction is handled by the "reportable_result" field in the result table.
test_type	Text(10); PK	Y	Type of test in the laboratory. This field is used to distinguish between initial runs, re-extractions, reanalysis and dilutions. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
cas_rn	Text(15); PK	Y	CAS Registry Number for this analyte. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
chemical_name	Text(255)	Y	Chemical Name
result_value	Numeric		Analytic result reported at an appropriate number of significant digits. Must be identical with values presented in the hard copy. Leave blank for non-detects. Coeluting congeners must all be reported with the same value.

Field Name	Data Type	Required	Comment
result_error_delta	Text(20)		Error range applicable to the result value; typically used only for radiochemistry results.
result_type_code	Text(10)	Y	Must be either "TRG" for a target or regular result, "TIC" for tentatively identified compounds, "SUR" for surrogates, "IS" for internal standards, or "SC" for spiked compounds.
reportable_result	Text(3)	Y	Must be "Yes" for results considered to be reportable, or "No" for other results. Used to distinguish most appropriate result when multiple results are generated due to dual-column tests or re-tests. Exactly one result (cas_rn) for each sample should have reportable_result = "Yes".
detect_flag	Text(2)	Y	Must be either "Y" for detected analytes or "N" for non_detects.
lab_qualifiers	Text(20)		Qualifier flags assigned by the laboratory. The lab is not restricted to using the qualifers in the reference values file; however, if a particular qualifier is used, the definition must be consistent with that in the reference values. The lab must provide an electronic key of laboratory-specific qualifiers used. Where a coeluting congener result is being reported, whether or not it is a detected result, this field will ALSO contain a "C", immediately followed by the lowest numbered congener of the coeluting set.
organic_yn	Text(1)	Y	Must be either "Y" for organic constituents or "N" for inorganic constituents.
method_detection_limit	Text(20)		Use the Method Detection Limit (MDL) for Organic compounds with the following exceptions; use the EDL for single component organics analyzed by isotope dilution methods; the highest EDL in the homolog for PCB homologs; the EDL of a single compent for Alkyl PAH homologs; and the instrument detection limit (IDL) for Inorganic compounds, per the contract. It must reflect such factors as dilution factors and moisture content.
reporting_detection_limit	Numeric		Use the value of the quantitation_limit except in the following cases: use the EDL for single component organics analyzed by isotope dilution methods; the highest EDL in the homolog for PCB homologs; the EDL of a single compent for Alkyl PAH homologs; and the result_value for radionuclides. Reflects conditions such as dilution factors and moisture content. Required for all results for which such a limit is appropriate. Must be identical to the non-detect value in the hard-copy report.

Field Name	Data Type	Required	Comment
quantitation_limit	Text(20)		Concentration level above which results can be quantified with 95% confidence limit. Must reflect conditions such as dilution factors and moisture content. Required for all results for which such a limit is appropriate.
result_unit	Text(15)	Y	Units of measurement for the result unit. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
detection_limit_unit	Text(15)		Units of measurement for the detection limit(s). Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
tic_retention_time	Text(8)		TIC Retention Time in units of decimal minutes.
result_comment	Text(254)		Result specific comments.
qc_original_conc	Numeric		The concentration of the analyte in the original (unspiked) sample. Required for spikes. Not necessary for surrogate compounds or LCS samples (where the original concentration is assumed to be zero).
qc_spike_added	Numeric		The concentration of the analyte added to the original sample. Required for spikes, surrogate compounds, LCS and any spiked sample.
qc_spike_measured	Numeric		The measured concentration of the analyte. Use zero for spiked compounds that were not detected in the sample. Required for spikes, surrogate compounds, LCS and any spiked sample.
qc_spike_recovery	Numeric		The percent recovery calculated as specified by the laboratory QC program. Required for spikes, surrogate compounds, LCS and any spiked sample. Report as percentage multiplied by 100 (e.g., report "120%" as "120").
qc_dup_original_conc	Numeric		The concentration of the analyte in the original (unspiked) sample. Required for spike duplicates only. Not necessary for surrogate compounds or LCS samples (where the original concentration is assumed to be zero).
qc_dup_spike_added	Numeric		The concentration of the analyte added to the original sample. Required for spike or LCS duplicates, surrogate compounds, and any spiked and duplicated sample. Use zero for spiked compounds that were not detected in the sample. Also complete the qc-spike-added field.
qc_dup_spike_measured	Numeric		The measured concentration of the analyte in the duplicate. Use zero for spiked compounds that were not detected in the sample. Required for spike and LCS duplicates, surrogate compounds, and any other spiked and duplicated sample. Also complete the qc-spike-measured field.

Field Name	Data Type	Required	Comment
qc_dup_spike_recovery	Numeric		The duplicate percent recovery calculated. Always required for spike or LCS duplicates, surrogate compounds, and any other spiked and duplicated sample. Also complete the qc-spike-recovery field. Report as percentage multiplied by 100 (e.g., report "120%" as "120").
qc_rpd	Numeric		The relative percent difference calculated. Required for duplicate samples as appropriate. Report as percentage multiplied by 100 (e.g., report "20%" as "20").
qc_spike_lcl	Numeric		Lower control limit for spike recovery. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as percentage multiplied by 100 (e.g., report "120%" as "120").
qc_spike_ucl	Numeric		Upper control limit for spike recovery. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as percentage multiplied by 100 (e.g., report "120%" as "120").
qc_rpd_cl	Numeric		Relative percent difference control limit. Required for any duplicated sample. Report as percentage multiplied by 100 (e.g., report "20%" as "20").
qc_spike_status	Text(10)		Used to indicate whether the spike recovery was within control limits. Use the "*" character to indicate failure, otherwise leave blank. Required for spikes, surrogate compounds, LCS and any spiked sample.
qc_dup_spike_status	Text(10)		Used to indicate whether the duplicate spike recovery was within control limits. Use the "*" character to indicate failure, otherwise leave blank. Required for any spiked and duplicated sample.
qc_rpd_status	Text(10)		Used to indicate whether the relative percent difference was within control limits. Use the "*" character to indicate failure, otherwise leave blank. Required for any duplicated sample.
uncertainty	Text(10)		Radiological analysis: uncertainty.
minimum_detectable_conc	Numeric		Radiological analysis: minimum detectable concentration.
counting_error	Numeric		Radiological analysis: counting error.
critical_value	Numeric		Radiological analysis: critical value.

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40); PK	Y	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. Sample IDs for field samples must be reported exactly as found on the chain of custody form, and may not be changed for subsequent tests (dilution, re-analysis, leachate, etc.)
lab_anl_method_name	Text(35); PK	Y	Laboratory analytic method name or description. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD. The method name should be sufficient to reflect operation of the laboratory. For example both "SW8080-pest" and "SW8080-PCB" may be necessary to distinguish between laboratory methods, while "SW8080" may not provide sufficient detail.
analysis_date	Date; PK	Y	Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by AECOM project manager.
analysis_time	Time; PK	Y	Time of sample analysis in 24-hr (military) HH:MM format. Time zone and daylight savings must be same as analysis_date.
total_or_dissolved	Text(10); PK	Y	Sample fraction tested. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
column_number	Text(2); PK	Y	Either "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses for which neither "1C" nor "2C" is applicable. If any "2C" tests are reported, then there must be corresponding "1C" tests present also. Also, laboratories typically can report which of the two columns is to be considered "primary". This distinction is handled by the "reportable_result" field in the result table.
test_type	Text(10); PK	Y	Type of test in the laboratory. This field is used to distinguish between initial runs, re-extractions, reanalysis and dilutions. Limited to values as found in the Reference values file, if additions must be made, they need to be approved by AECOM before submitting an EDD.
test_batch_type	Text(10); PK	Y	Lab Batch type. Should be "Prep" or "Analysis" or "Leach"
test_batch_id	Text(20)	Y	Unique identifier for all lab batches. Each batch must contain at least one field sample, and samples can participate in more than one batch, as long as the batch type is unique.

LoadDVA EDD:

Analytical data qualification and validation.

Field Name	Data Type	Required	Comment
facility_id	Numeric	Y	
test_id	Numeric	Y	
lab_name_code	Text(2147483647)		
lab_sdg	Text(2147483647)		
sys_sample_code	Text(2147483647)	Y	
lab_sample_id	Text(2147483647)		
matrix_code	Text(2147483647)		
sample_type_code	Text(2147483647)		
sample_date	Text(2147483647)		
chain_of_custody	Text(2147483647)		
basis	Text(2147483647)		
fraction	Text(2147483647)	Y	
column_number	Text(2147483647)	Y	
percent_moisture	Text(2147483647)		
prep_method	Text(2147483647)		
prep_date	Text(2147483647)		
analytic_method	Text(2147483647)	Y	
test_type	Text(2147483647)	Y	
analysis_date	Text(2147483647)	Y	
dilution_factor	Text(2147483647)		
batches	Text(2147483647)		
result_type_code	Text(10)	Y	
cas_rn	Text(15)	Y	
chemical_name	Text(2147483647)		
result_text	Numeric		
result_error_delta	Numeric		
detect_flag	Text(2)	Y	
reporting_detection_limit	Numeric		
method_detection_limit	Numeric		
quantitation_limit	Numeric		
result_unit	Text(2147483647)		
lab_qualifiers	Text(15)		
reportable_result	Text(3)	Y	
validator_qualifiers	Text(20)		
interpreted_qualifiers	Text(20)		
reason_code	Text(20)		

Field Name	Data Type	Required	Comment
facility_id	Numeric	Y	
test_id	Numeric	Y	
validated_by	Text(50)	Y	
validated_date	Date	Y	
level_validated	Text(15)		

EQEDD EDD:

For loading historical data.

Field Name	Data Type	Required	Comment
data_provider	Text(40)		Name of company or agency responsible for completion and submittal of any part of this EDD.
data_contact_person	Text(50)		Name of contact associated with data_provider.
data_contact_address1	Text(40)		Data contact street address and/or box number.
data_contact_address2	Text(40)		Data contact address, part two. Box number or other info.
data_contact_city	Text(30)		Data provider City.
data_contact_state	Text(10)		Postal abbreviation for Data provider state.
data_contact_zipcode	Text(30)		Data provider zip code.
data_contact_email	Text(100)		Contact e-mail address.
data_contact_phone	Text(30)		Contact phone number.

Field Name	Data Type	Required	Comment
task_code	Text(40)	Y	Code used to identify the task under which the field sample was taken
task_desc	Text(255)		Task description
start_date	DateTime		Task start date
end_date	DateTime		Task end date
delivery_order	Text(20)		Delivery order
client	Text(50)		Client

Field Name	Data Type	Required	Comment
subfacility_code	Text(20)	Y	Subfacility code
subfacility_type	Text(20)		Subfacility Type
subfacility_name	Text(60)		Subfacility name
task_code	Text(40)		Code used to identify the task under which the field sample was taken
remark_1	Text(2000)		Subfacility description
remark_2	Text(2000)		Remark 2
contact_name	Text(50)		Contact name
address_1	Text(40)		Address 1
address_2	Text(40)		Address 2
city	Text(30)		City
county	Text(50)		County
state	Text(10)		State
zipcode	Text(230)		Zip code
phone_number	Text(30)		Phone number
alt_phone_number	Text(30)		Alternate phone number
fax_number	Text(30)		Fax number
email_address	Text(100)		Email address

Field Name	Data Type	Required	Comment
data_provider	Text(40)		Data Provider
sys_loc_code	Text(20)	Y	Location identifier of sample collection, soil boring, or well installation. Examples of possible sys_loc_code are MW-01, A-1, SB6, etc.
x_coord	Numeric		Sampling location numeric X coordinate
y_coord	Numeric		Sampling location numeric Y coordinate
surf_elev	Numeric		Sampling location surface elevation
elev_unit	Text(15)		Unit of measurement for elevations
coord_type_code	Text(20)		Sampling location coordinate system description
observation_date	DateTime		Date observation or site survey was made
coord_identifier	Text(20)		This field is a coordinate identifier. Typical values include 'PRIMARY', 'SECONDARY' or '1', '2'
horz_collect_method_code	Text(20)		Use codes in horizontal collection method valid value table in appendix. Method used to determine the latitude/longitude.
horz_accuracy_value	Text(20)		Accuracy range (+/-) of the latitude and longitude. Only the least accurate measurement should be reported, regardless if it is for latitude or longitude.
horz_accuracy_unit	Text(15)		Unit of the horizontal accuracy value
horz_datum_code	Text(20)		Reference datum of the latitude and longitude
elev_collect_method_code	Text(20)		Method used to determine the ground elevation of the sampling location
elev_accuracy_value	Text(20)		Accuracy range (+/-) of the elevation measurement
elev_accuracy_unit	Text(15)		Unit of the elevation accuracy value
elev_datum_code	Text(20)		Reference datum for the elevation measurement
source_scale	Text(20)		Scale of the source used to determine the latitude and longitude
subcontractor_name_code	Text(40)		Name or code of sampling company
verification_code	Text(20)		Verification code
reference_point	Text(50)		Describes the place at which geologic coordinates were established
geometric_type_code	Text(20)		Geometric type code
rank	Numeric		Rank
loc_name	Text(40)		Sampling location name
loc_desc	Text(255)		Sampling location description
loc_type	Text(20)		Sampling location type
loc_purpose	Text(50)		Sampling location purpose
subfacility_code	Text(20)		Unique code for site or area
within_facility_yn	Text(1)		Indicates whether this sampling location is within facility boundaries, 'Y' for yes or 'N' for no.
loc_county_code	Text(30)		Location county code; controlled vocabulary using FIPS (Federal Information Processing Standard) codes. FIPS codes can be found via the internet at http://www.itl.nist.gov/fipspubs/ or http://www.oseda.missouri.edu/jgb/geos.html
loc_district_code	Text(20)		Location district code; controlled vocabulary using FIPS codes
loc_state_code	Text(10)		Location state code; controlled vocabulary using FIPS codes
loc_major_basin	Text(20)		Location major basin; controlled vocabulary using HUC (Hydrologic Unit Codes). HUC codes can be found via the internet at http://www.epa.gov/surf. The first 8 digits of the HUC code should be entered here.
loc_minor_basin	Text(20)		Location minor basin; controlled vocabulary using HUC codes. Any digits after the 8th (first 8 are reported in loc_major_basin) should be reported here.
remark	Text(2000)		Location specific comment.
total_depth	Numeric		Total depth below ground surface of boring, in feet.
depth_to_bedrock	Numeric		Depth below ground surface of bedrock in feet.
depth_to_top_of_screen	Numeric		Depth below ground surface to the top of the well screen. This information is required to obtain the vertical location from which the groundwater sample was taken. Leave null if sample is not from well.

Field Name	Data Type	Required	Comment
depth_to_bottom_of_screen	Numeric		Depth below ground surface to bottom of well screen. This information is required to obtain the vertical location from which the groundwater sample was taken. Leave null if sample is not from well.
depth_unit	Text(15)		Unit of measurement for depths
top_casing_elev	Numeric		Elevation of the top of casing. Leave null if sample is not from well.
datum_value	Numeric		Datum value
datum_unit	Text(15)		Datum unit
step_or_linear	Text(6)		Step or linear
datum_collection_method_code	Text(20)		Datum collection method code
datum_desc	Text(255)		Datum description
datum_start_date	DateTime		Datum start date
geologist	Text(50)		Geologist
inspector	Text(50)		Inspector
bore_id	Text(30)		The identifier of the drilled borehole.
loc_type_2	Text(30)		A secondary field for the type of location.
log_date	DateTime		The date the location was logged.
stream_code	Text(30)		The identifying code that describes the stream nearest to a specific location.
stream_mile	Numeric		This indicates where the river or stream (stream_code) for the station exists.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique Location Name
parameter_code	Text(20)	Y	Code used to identify parameter being measured, observed, or attribute being described
parameter_value	Text(255)		Value of parameter
parameter_unit	Text(15)		Parameter unit
measurement_date	DateTime		Date of parameter measurement or observation
measurement_method	Text(20)		Measurement method
remark	Text(2000)		Remark
task_code	Text(40)		Code used to identify the task under which the field sample was taken.
activity_type	Text(40)		required for EDGE

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Soil boring or well installation location. Must be a valid code for the facility and reported value in the sys_loc_code field of the location file.
drill_event	Text(20)	Y	Used to identify drilling event. Examples of drilling events could be 'INITIAL' for initial drilling or 'SECOND' for a subsequent drilling at the same sys_loc_code.
start_depth	Numeric		The start depth, in feet, below ground surface of the drilling activity.
end_depth	Numeric		End depth, in feet, below ground surface of the drilling activity.
drill_start_date	DateTime		Date drilling began
drill_end_date	DateTime		Date drilling concluded
diameter	Numeric		Diameter of boring
diameter_unit	Text(15)		Use values from Unit valid value table. Unit of measure for diameter.
drill_method	Text(50)		Method used to drill boring
fluid	Text(50)		Description of fluid used during drilling
viscosity	Text(50)		Viscosity of drilling fluid
hammer_wt	Text(50)		Weight of hammer, in pounds, used for sampling
hammer_fall	Text(50)		Distance of hammer fall during sampling
lift_mechanism	Text(50)		Type of mechanism used to lift hammer
new_yn	Text(1)		Is this a new boring? 'Y' for yes or 'N' for no
repair_yn	Text(1)		Is this drilling event to repair an existing boring? 'Y' for yes or 'N' for no
deepen_yn	Text(1)		Is this drilling event to deepen an existing boring? 'Y' for yes or 'N' for no
abandon_yn	Text(1)		Has the boring been abandoned? 'Y' for yes or 'N' for no
replace_yn	Text(1)		Is this drill event to replace an existing boring? 'Y' for yes or 'N' for no
public_yn	Text(1)		Is well being install for a public use? ? 'Y' for yes or 'N' for no
purpose	Text(70)		Describe the purpose of the drill event
rig_desc	Text(50)		Description of drilling rig
drilling_subcontractor	Text(40)		Drilling subcontractor
driller	Text(50)		Driller

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Soil boring or well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file (Table 3-2).
start_depth	Numeric	Y	The start depth of the lithologic layer
material_type	Text(40)		The type of material that composes the lithologic unit. Controlled vocabulary, see material list in appendix. Must be used in all cases except when a depth specific comment is being made.
geo_unit_code_1	Text(20)		The data providers interpretation of the hydrogeologic unit present at this lithologic unit, e.g., aquifer 1, aquitard 1, aquifer 2, upper clay unit
geo_unit_code_2	Text(20)		Alternate geologic unit grouping. This can be a sub-classification of geologic_unit_code_1 or a layer used for groundwater flow/transport computer modelling that contains the lithologic unit.
remark1	Text(2000)		Comment on the lithologic unit
remark2	Text(2000)		Comment on the geologic unit
moisture	Text(20)		What degree of moisture was observed within the lithologic unit?
permeable	Text(20)		Description of the permeability of the lithologic unit such as 'impervious', 'semi', 'pervious,' or 'very'.
consolidated_yn	Text(1)		Was lithologic unit consolidated? 'Y' for yes or 'N' for no.
color	Text(30)		Color of lithologic layer
observation	Text(255)		General field observations of the lithologic unit
consistency	Text(20)		Description of the consistency of the soil such as 'very soft', 'soft, 'firm', 'hard' or 'very hard'
sorting	Text(20)		Geologic description of the grain size distribution of the lithologic unit. Use 'poor' for soil with a wide range of particle sizes or 'well' for soil with a narrow range of particle sizes.
grainsize	Text(20)		Description of grain size
odor	Text(20)		Description of odor from the soil
end_depth	Numeric		The end depth of the lithologic layer.
density	Text(20)		Density

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file.
well_id	Text(30)		Well ID
well_description	Text(255)		Used for additional well description, if necessary
well_owner	Text(50)		Name of entity that owns the well
well_purpose	Text(20)		Purpose of well
well_status	Text(20)		Current status of well
top_casing_elev	Numeric		Elevation of the top of well casing
datum_value	Numeric		Value of datum used to reference water level measurements
datum_unit	Text(15)		Unit of measure for the well datum
datum_desc	Text(255)		Description of the datum, such as 'top of well casing'
step_or_linear	Text(6)		If a section of the well casing was removed or added use 'step' as the value. If nothing was added or removed from the last survey use 'linear' as the value.
datum_start_date	DateTime		Date that datum was first used in MM/DD/YYYY format
datum_collection_method_code	Text(20)		Method used to determine the datum elevation
depth_of_well	Numeric		Depth below ground surface of the well bottom
depth_unit	Text(15)		Unit of measurement for depth
depth_measure_method	Text(20)		Method of measuring depth of well
stickup_height	Text(8)		Height of casing above ground surface
stickup_unit	Text(15)		Unit of measure for the stickup height
sump_length	Text(20)		Length of sump
sump_unit	Text(15)		Unit of measure for the sump length
installation_date	DateTime		Date of well installation in MM/DD/YYYY format
construct_start_date	DateTime		Date well construction began in MM/DD/YYYY format
construct_complete_date	DateTime		Date well construction was completed in MM/DD/YYYY format
construct_contractor	Text(40)		Name of contractor that installed well
pump_type	Text(20)		Type of pump used at well such as centrifugal, propeller, jet, helical, rotary, etc.
pump_capacity	Text(6)		Capacity of pump
pump_unit	Text(15)		Unit of measure for the pump capacity and yield
pump_yield	Text(6)		The yield of the pump
pump_yield_method	Text(20)		Method used for pump yield
weep_hole	Text(1)		Is there a weep hole? 'Y' for yes or 'N' for no
head_configuration	Text(50)		Description of the well head
access_port_yn	Text(1)		Is there an access port? 'Y' for yes or 'N' for no
casing_joint_type	Text(50)		Type of casing joint such as threaded, flush, or solvent welded
perforator_used	Text(50)		Description of well perforation such as slotted, drilled, or wound
intake_depth	Numeric		Depth below ground surface of the well intake
disinfected_yn	Text(1)		Was well disinfected? 'Y' for yes or 'N' for no
historical_reference_elev	Numeric		Historical reference value. Used for the elevation of past reference points
geologic_unit_code	Text(20)		Geologic unit in which the well intake is installed
remark	Text(2000)		General remarks

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Soil boring or well installation location. Must be a valid code for the facility and reported in the location file either now or during an earlier data submission
segment_type	Text(20)	Y	Type of segment within well (e.g., protective casing, well casing, screen, etc.)
material_type_code	Text(20)	Y	Material description of well segment
start_depth	Numeric	Y	Depth below ground surface of the top of the segment
end_depth	Numeric	Y	Depth below ground surface of the bottom of the segment
depth_unit	Text(15)	Y	The unit of depth measurements
inner_diameter	Numeric		The inside diameter of segment
outer_diameter	Numeric		The outside diameter of the segment
diameter_unit	Text(15)		The unit of measure for diameter measurement
thickness	Numeric		Thickness of the well segment
thickness_unit	Text(15)		The unit of measurement for thickness
slot_type	Text(20)		Type of slots such as bridge, shutter, and continuous
slot_size	Numeric		Width of slots
slot_size_unit	Text(15)		The unit of measurement for slot size
perf_length	Numeric		Length of perforated portion of screen
screen_type	Text(15)		Type of screen
material_quantity	Text(20)		Quantity of material used. Applicable to annular seal/fill material.
material_density	Text(20)		Density of the annular seal material
remark	Text(2000)		Remarks regarding the well segment

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Sample collection location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file.
geo_sample_code	Text(40)	Y	Unique sample identifier. Considerable flexibility is given in the methods used to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced.
sample_name	Text(50)		Use to provide a name or description of sample. Does not have to be a unique.
sample_top	Numeric	Y	Depth, in feet below ground surface, to top of sample
sample_bottom	Numeric	Y	Depth, in feet below ground surface, to bottom of sample
sample_date	DateTime		Date sample was collected in MM/DD/YYYY HH:MM:SS format
sample_method	Text(40)		Method used to obtain sample
material_type	Text(40)		Material type of geologic sample
sample_desc	Text(255)		General description of the sample or sampling activities
geologic_unit_code	Text(20)		Code used to identify the geologic unit of sample
liquid_limit	Numeric		Liquid limit of sample
plastic_limit	Numeric		Plastic limit of sample
shrinkage_limit	Numeric		Shrinkage limit of sample
flow_index	Numeric		Flow index of sample
plasticity_index	Numeric		Plasticity index of sample
activity	Numeric		Activity of sample
e	Numeric		Void ratio of sample
e_max	Numeric		Maximum void ratio of sample
e_min	Numeric		Minimum void ratio of sample
n	Numeric		Porosity of sample
specific_gravity	Numeric		Specific gravity of sample
w	Numeric		Water content of sample
opt_w	Numeric		Optimum water content
s	Numeric		Degree of saturation of the sample
K	Numeric		Hydraulic conductivity of sample
K_unit	Text(15)		Unit of measure for K
unit_wt	Numeric		Unit weight of sample
sat_unit_wt	Numeric		Saturated unit weight
dry_unit_wt	Numeric		Dry unit weight
dry_unit_wt_max	Numeric		Maximum dry unit weight
dry_unit_wt_min	Numeric		Minimum dry unit weight
density_unit	Text(15)		Unit of measure for the density of the sample
rel_density	Numeric		Relative density of sample
rel_compaction	Numeric		Relative compaction of sample
consistency	Text(20)		Description of the consistency of the soil sample such as very soft, soft, firm, hard or very hard
organic_carbon	Numeric		Organic carbon content of sample
organic_carbon_unit	Text(15)		Unit of measurement of organic carbon

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Soil boring or well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file.
measurement_date	DateTime	Y	Date and time of water level measurement in MM/DD/YYYY HH:MM:SS format
equipment_code	Text(60)		Equipment code used to define equipment used during sampling event.
historical_reference_elev	Numeric		Historical reference value. Used for the elevation of past reference points. Elevation must be in feet.
water_level_depth	Numeric		Depth of ground water below datum defined in well table
water_level_elev	Numeric		Elevation of water level. Elevation must be in feet.
corrected_depth	Numeric		Depth of water level after any necessary corrections, e.g., if corrections were necessary to water_level_depth because free product was encountered
corrected_elev	Numeric		Corrected water level elevation. Elevation must be in feet.
measured_depth_of_well	Numeric		The depth below ground surface to the bottom of the well
depth_unit	Text(15)		Use values from Unit valid value table. Unit of measure for depths.
technician	Text(50)		Name of technician
dry_indicator_yn	Text(1)		Is the well dry? 'Y' for yes or 'N' for no
measurement_method	Text(20)		Method used to make water level measurements
batch_number	Text(10)		Batch number
dip_or_elevation	Text(10)	Y	Use either 'elevation' or 'dip'. Use 'elevation' if water level measurement is above the datum (i.e., artesian well) or 'dip' if water level is below datum.
remark	Text(2000)		Remark on measurement
lnapl_cas_rn	Text(15)		LNAPL_cas_rn
lnapl_depth	Numeric		LNAPL_depth
dnapl_cas_rn	Text(15)		DNAPL_cas_rn
dnapl_depth	Numeric		DNAPL_depth
task_code	Text(40)		Code used to identify the task under which the field sample was taken
approval_code	Text(10)		Approval code.
custom_field_1	Text(255)		Custom field.
custom_field_2	Text(255)		Custom field.
custom_field_3	Text(255)		Custom field.
custom_field_4	Text(255)		Custom field.
custom_field_5	Text(255)		Custom field.
reportable_yn	Text(1)	Y	Must be either "Y" for water levels which are considered to be reportable and final, or "N" for all other water level readings. This field can be used to distinguish between multiple water level readings where only the final reading would be used for reporting.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Soil boring or well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file.
type	Text(20)	Y	Aquifer designation such as unconfined1, confined1, or confined2
sequence	Text(20)	Y	Designation of when water level measurement was taken. For example, measurement before water stabilized would be 'unstabilized' and after stabilization would be 'stabilized'.
depth	Numeric	Y	Depth of water table below reference point
flowing_yn	Text(1)		Is the water table flowing? 'Y' for yes or 'N' for no
measurement_method	Text(50)		Method of measuring water table depth
capped_pressure	Numeric		Hydrostatic pressure of confined aquifer
capped_pressure_unit	Text(15)		Unit of measure for capped pressure
reference_point	Text(50)		Description of reference point from which depth were measured
reference_elevation	Numeric		The reference point elevation
temperature	Numeric		Temperature of water in the water table
temperature_unit	Text(15)		Unit of temperature

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Soil boring or well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file.
depth	Numeric	Y	Depth of measurement below ground surface
param	Text(20)	Y	The parameter being measured such as tip stress, resistivity, or pore pressure
param_value	Numeric	Y	The measured value of the parameter
param_unit	Text(15)		The unit of the measured value

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Well installation code
start_measure_date	DateTime	Y	Date and time that the pumping measures began in MM/DD/YYYY HH:MM:SS format
end_measure_date	DateTime	Y	Date and time that the pumping measures concluded in MM/DD/YYYY HH:MM:SS format
ave_pump_rate	Numeric	Y	Average pumping rate. Recommended method: volume pumped divided by reported measurement date span
pump_rate_unit	Text(15)	Y	Unit of measure for the pumping rate
pct_operating_time	Numeric		Percentage of the measurement time interval that the well was operating. 0 - 100 (no %)
operating_mode	Text(20)	Y	Mode in which well was operating during the reported interval
design_rate	Numeric	Y	Pumping rate specified in the remedial design to fully capture site's contamination
design_rate_unit	Text(15)	Y	Unit of measure for the design pumping rate
rate_measurement_type	Text(20)		Type of measurement used for averaging
suction	Numeric		Vacuum in well (e.g. wellpoint vacuum) or well casing (e.g. vacuum well) in equivalent feet of water
remark	Text(2000)		Remarks regarding the pumping rate measurements

Field Name	Data Type	Required	Comment
equipment_code	Text(60)	Y	Unique equipment identifier.
equipment_type	Text(30)		Type of equipment
equipment_desc	Text(255)		Description of equipment
sys_loc_code	Text(20)		Location at which equipment is installed, used, or with which it is associated
model_number	Text(50)		Model number
catalog_number	Text(50)		Catalog number
manufacturer	Text(50)		Manufacturer of equipment
owner	Text(50)		Owner of equipment
operation_status	Text(20)		Operational status of equipment
install_date	DateTime		Date of equipment installation
last_service_date	DateTime		Date equipment was last serviced
next_service_date	DateTime		Date equipment is scheduled to be serviced
purchase_date	DateTime		Date of equipment purchase
purchase_price	Numeric		Cost of equipment
material	Text(50)		Material
size	Text(20)		Size
size_unit	Text(15)		Size unit of measure
remark	Text(2000)		Remark.

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique Location ID
start_date	DateTime	Y	Date and time the purge operation was started
end_date	DateTime		Date and time the purge operation was completed
sampling_zone	Text(20)		Description of zone that was sampled
depth_unit	Text(15)		Unit of measurement for the purge depth
depth_to_water	Text(8)		Depth to water
flowmeter_start	Text(20)		Start reading of flowmeter
purge_vol	Text(7)		Purged volume
purge_vol_unit	Text(15)		Unit of purged volume
purge_rate	Text(10)		Purge rate
purge_rate_unit	Text(15)		Purge rate unit
purge_purpose	Text(20)		Purpose of purge
purge_method	Text(50)		Purge method
remark	Text(2000)		Remark
task_code	Text(40)		Task code

Field Name	Data Type	Required	Comment
sys_loc_code	Text(20)	Y	Unique Station ID. Required for mapping.
field_parameter	Text(15)	Y	Field parameter.
start_depth	Numeric	Y	Sample start depth
depth_unit	Text(15)	Y	Sample depth unit.
result_date	DateTime	Y	Result date/time (MM/DD/YYYY HH:MM:SS).
result_value	Text(14)		Result value.
result_unit	Text(15)		Result unit.
source	Text(255)		Source
source_method	Text(255)		Source method.
source_extent	Text(255)		Source extent.
custom_field_1	Text(255)		Custom field.
custom_field_2	Text(255)		Custom field.
custom_field_3	Text(255)		Custom field.
custom_field_4	Text(255)		Custom field.
custom_field_5	Text(255)		Custom field

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40)	Y	Unique sample identifier. Each sample at a facility must have a unique value, including spikes and duplicates. You have considerable flexibility in the methods used to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS®.
sample_name	Text(50)		Additional sample identification information as necessary. Is not required to be unique (i.e., duplicates are OK).
sample_matrix_code	Text(10)	Y	Code which distinguishes between different types of sample matrix. For example, soil samples must be distinguished from ground water samples, etc.
sample_type_code	Text(20)	Y	Code which distinguishes between different types of samples. For example, normal field samples must be distinguished from laboratory method blank samples, etc.
sample_source	Text(10)	Y	This field identifies where the sample came from, either Field or Lab. In this import, this should always be Field.
parent_sample_code	Text(40)		The value of "sys_sample_code" that uniquely identifies the sample that was the source of this sample. For example, the value of this field for a duplicate sample would identify the normal sample of which this sample is a duplicate.
sample_delivery_group	Text(20)		The sampling event with which the sample is associated.
sample_date	DateTime	Y	Date and time sample was collected (in MM/DD/YYYY HH:MM:SS format)
sys_loc_code	Text(20)		Soil boring or well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file. Field should be null if field QC sample (e.g., field blank, trip blank, etc.)
start_depth	Numeric		Beginning depth (top) of sample in feet below ground surface. Leave null for most ground water samples from monitoring wells. Database will derive this information from the start/end depth of the well screen field located in another data table. Only use for groundwater samples if discrete samples are taken at different depth elevations from a single well, i.e. multiple well packer samples.
end_depth	Numeric		Ending depth (bottom) of sample in feet below ground surface. Leave null for most ground water samples from monitoring wells. Database will derive this information from the start/end depth of the well screen field located in another data table. Only use for groundwater samples if discrete samples are taken at different depth elevations from a single well, i.e. multiple well packer samples.
depth_unit	Text(15)		Unit of measurement for the sample begin and end depths
chain_of_custody	Text(40)		Chain of custody identifier. A single sample may be assigned to only one chain of custody.
sent_to_lab_date	DateTime		Date sample was sent to lab (in MM/DD/YYYY format)
sample_receipt_date	DateTime		Date that sample was received at laboratory (in MM/DD/YYYY format)
sampler	Text(50)		Name or initials of sampler
sampling_company_code	Text(40)	Y	Name or initials of sampling company (not controlled vocabulary)
sampling_reason	Text(30)		Report as null
sampling_method	Text(40)		Sampling method
task_code	Text(40)		Code used to identify the task under which the field sample was retrieved
collection_quarter	Text(6)		format: YYQ# where YY is year and # is 1, 2, 3, or 4 representing which quarter.
composite_yn	Text(1)	Y	Is sample a composite sample? 'Y' for yes or 'N' for no
composite_desc	Text(255)		Description of composite sample (if composite_yn is 'Yes')
sample_class	Text(10)		Report as null
custom_field_1	Text(255)		Report as null
custom_field_2	Text(255)		Report as null
custom_field_3	Text(255)		Report as null
geologic_unit_code	Text(20)		The geologic unit (e.g. stratigraphy) from which the sample was taken.
comment	Text(2000)		Comment
filter_type	Text(20)		Filter Type

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40)	Y	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. The laboratory and the EQuIS user have considerable flexibility in the methods they use to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS.
measurement_date	DateTime		Measurement date and time
param_code	Text(20)	Y	Parameter code
param_value	Text(255)		Parameter value
param_unit	Text(15)		Unit of measure for parameter value
measurement_method	Text(20)		Measurement method
remark	Text(2000)		Remark

Field Name	Data Type	Required	Comment
data_provider	Text(40)		Data Provider.
sys_loc_code	Text(20)	Y	Unique Station ID. Required for mapping.
sys_sample_code	Text(40)	Y	Sample code
cas_rn	Text(15)	Y	Field parameter by CASRN.
chemical_name	Text(255)	Y	Field parameter by chemical name.
start_depth	Numeric		Sample start depth
end_depth	Numeric		Sample end depth
depth_unit	Text(15)		Sample depth unit.
result_date	DateTime	Y	Result date/time (mm/dd/yr hh:mm:ss).
result_value	Numeric	Y	Result value.
result_unit	Text(15)	Y	Result unit.
quantitation_limit	Text(20)		Quantitation limit
task_code	Text(40)		Code used to identify the task under which the field sample was retrieved
sample_matrix_code	Text(10)	Y	Sample matrix code
qualifier	Text(2)		Qualifier
sampling_company_code	Text(40)		sampling reason
sampling_reason	Text(30)		sampling reason
sampling_method	Text(40)		Sampling method
reportable_result	Text(10)	Y	Reportable result
value_type	Text(10)	Y	How value was derived
remark	Text(2000)		Remark
detect_flag	Text(2)	Y	May be either 'Y' for detected analytes or 'N' for non_detects or 'TR' for trace. Use 'Y' for estimated values (above detection limit but below the quantitation limit).

Field Name	Data Type	Required	Comment
chain_of_custody	Text(40)	Y	
cooler_id	Text(10)		
cooler_temp	Numeric		
custom_field_1	Text(255)		
custom_field_2	Text(255)		
custom_field_3	Text(255)		
custom_field_4	Text(255)		
custom_field_5	Text(255)		
shipping_company	Text(40)		
shipping_tracking_number	Text(50)		
contact_name_1	Text(50)		
contact_name_2	Text(50)		
complete_yn	Text(1)		
cooler_count	Numeric		

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40)	Y	Unique sample identifier. Each sample at a facility must have a unique value, including spikes and duplicates. You have considerable flexibility in the methods used to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS.
sample_name	Text(50)		Additional sample identification information as necessary. Is not required to be unique (i.e., duplicates are OK).
sample_matrix_code	Text(10)	Y	Code which distinguishes between different types of sample matrix. For example, soil samples must be distinguished from ground water samples, etc.
sample_type_code	Text(20)	Y	Code which distinguishes between different types of samples. For example, normal field samples must be distinguished from laboratory method blank samples, etc.
sample_source	Text(10)	Y	This field identifies where the sample came from, either Field or Lab. In this import, this should always be Field.
parent_sample_code	Text(40)		The value of "sys_sample_code" that uniquely identifies the sample that was the source of this sample. For example, the value of this field for a duplicate sample would identify the normal sample of which this sample is a duplicate.
sample_delivery_group	Text(20)		The sampling event with which the sample is associated.
sample_date	DateTime	Y	Date and time sample was collected (in MM/DD/YYYY HH:MM:SS format for EDD)
sys_loc_code	Text(20)		Soil boring or well installation location. Must be a valid code for the facility and reported in the sys_loc_code field of the location file (Table 3-2).* Field should be null if field QC sample (e.g., field blank, trip blank, etc.)
start_depth	Numeric		Beginning depth (top) of sample in feet below ground surface. Leave null for most ground water samples from monitoring wells. Database will derive this information from the start/end depth of the well screen field located in another data table. Only use for groundwater samples if discrete samples are taken at different depth elevations from a single well, i.e. multiple well packer samples.
end_depth	Numeric		Ending depth (top) of sample in feet below ground surface. Leave null for most ground water samples from monitoring wells. Database will derive this information from the start/end depth of the well screen field located in another data table. Only use for groundwater samples if discrete samples are taken at different depth elevations from a single well, i.e. multiple well packer samples.
depth_unit	Text(15)		Unit of measurement for the sample begin and end depths
chain_of_custody	Text(40)		Chain of custody identifier. A single sample may be assigned to only one chain of custody.
sent_to_lab_date	DateTime		Date sample was sent to lab (in MM/DD/YYYY format for EDD)
sample_receipt_date	DateTime		Date that sample was received at laboratory (in MM/DD/YYYY format for EDD)
sampler	Text(50)		Name or initials of sampler
sampling_company_code	Text(40)	Y	Name or initials of sampling company (not controlled vocabulary)
sampling_reason	Text(30)		Report as null
sampling_method	Text(40)		Sampling method
task_code	Text(40)		Code used to identify the task under which the field sample was retrieved
collection_quarter	Text(6)		Format: YYQ# where YY is year and # is 1,2,3,or 4 representing what quarter
composite_yn	Text(1)	Y	Is sample a composite sample? 'Y' for yes or 'N' for no
composite_desc	Text(255)		Description of composite sample (if composite_yn is 'Yes')
sample_class	Text(10)		Report as null
custom_field_1	Text(255)		Report as null
custom_field_2	Text(255)		Report as null
custom_field_3	Text(255)		Report as null
comment	Text(2000)		Comment

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40)	Y	Unique sample identifier. Each sample at a facility must have a unique value, including spikes and duplicates. You have considerable flexibility in the methods used to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS.
lab_anl_method_name	Text(20)	Y	Laboratory analytical method name or description. A controlled vocabulary column, valid values can be found in the appendix in table lab_anl_method_name.
analysis_date	DateTime	Y	Date and time of sample analysis in MM/DD/YYYY HH:MM:SS format. May refer to either beginning or end of the analysis as required by EPA.
total_or_dissolved	Text(10)	Y	Must be either 'D' for dissolved or filtered [metal] concentration, 'T' for total or undissolved, or 'N' for anything else
column_number	Text(2)		Values include either '1C' for first column analyses, '2C' for second column analyses or 'NA' for tests for which this distinction is not applicable.
test_type	Text(10)	Y	Type of test. Valid values include 'INITIAL', 'REEXTRACT1', 'REEXTRACT2', 'REEXTRACT3', 'REANALYSIS', 'DILUTION1', 'DILUTIONS2', and 'DILUTIONS3'
lab_matrix_code	Text(10)		Code which distinguishes between different type of sample matrix. For example, soil samples must be distinguished from ground water samples, etc. The matrix of the sample as analyzed may be different from the matrix of the sample as retrieved (e.g. leachates), so this field is available at both the sample and test level.
analysis_location	Text(2)	Y	Must be either 'FI' for field instrument or probe, 'FL' for mobile field laboratory analysis, or 'LB' for fixed_based laboratory analysis
basis	Text(10)	Y	Must be either 'Wet' for wet_weight basis reporting, 'Dry' for dry_weight basis reporting, or 'NA' for tests for which this distinction is not applicable. The EPA prefers that results are reported on the basis of dry weight where applicable.
container_id	Text(30)		Report as null
dilution_factor	Numeric		Effective test dilution factor
prep_method	Text(20)		Laboratory sample preparation method name or description
prep_date	DateTime		Beginning date and time of sample preparation in MM/DD/YYYY HH:MM:SS format
leachate_method	Text(15)		Laboratory leachate generation method name or description. The method name should be sufficient to reflect operation of the laboratory.
leachate_date	DateTime		Beginning date and time of leachate preparation in MM/DD/YYYY HH:MM:SS format
lab_name_code	Text(40)		Unique identifier of the laboratory
qc_level	Text(10)		May be either 'screen' or 'quant'
lab_sample_id	Text(40)		Laboratory LIMS sample identifier. If necessary, a field sample may have more than one LIMS lab_sample_id (maximum one per each test event)
percent_moisture	Text(5)		Percent moisture of the sample portion used in this test; this value may vary from test to test for any sample. Numeric format is 'NN.MM', i.e., 70.1% could be reported as '70.1' but not as '70.1%'.
subsample_amount	Text(14)		Amount of sample used for test
subsample_amount_unit	Text(15)		Unit of measurement for subsample amount
analyst_name	Text(50)		Report as null
instrument_id	Text(60)		Instrument identifier
comment	Text(2000)		Comments about the test
preservative	Text(20)		Sample preservative used
final_volume	Numeric		The final volume of the sample after sample preparation. Include all dilution factors.
final_volume_unit	Text(15)		The unit of measure that corresponds to the final_amount
cas_rn	Text(15)	Y	Use values in analyte valid value table
chemical_name	Text(255)	Y	Use the name in the analyte valid value table
result_value	Numeric		Analytical result reported at an appropriate number of significant digits. May be blank for non-detects.
result_error_delta	Text(20)		Error range applicable to the result value; typically used only for radiochemistry results.
result_type_code	Text(10)	Y	Must be either 'TRG' for a target or regular result, 'TIC' for tentatively identified compounds, 'SUR' for surrogates, 'IS' for internal standards, or 'SC' for spiked compounds
reportable_result	Text(10)	Y	Must be either 'Yes' for results which are considered to be reportable, or 'No' for other results. This field has many purposes. For example, it can be used to distinguish between multiple results where a sample is retested after dilution. It can also be used to indicate which of the first or second column result should be considered primary. The proper value of this field in both of these two examples should be provided by the laboratory (only one result should be flagged as reportable).
detect_flag	Text(2)	Y	May be either 'Y' for detected analytes or 'N' for non_detects or 'TR' for trace. Use 'Y' for estimated values (above detection limit but below the quantitation limit).
lab_qualifiers	Text(20)		Qualifier flags assigned by the laboratory

Field Name	Data Type	Required	Comment
validator_qualifiers	Text(20)		Qualifier flags assigned by the validation firm.
interpreted_qualifiers	Text(20)		Qualifier flags assigned by the validation firm
organic_yn	Text(1)	Y	Must be either 'Y' for organic constituents or 'N' for inorganic constituents
method_detection_limit	Text(20)		Method detection limit
reporting_detection_limit	Numeric		Concentration level above which results can be quantified with confidence. It must reflect conditions such as dilution factors and moisture content. Required for all results for which such a limit is appropriate. The reporting_detection_limit column must be reported as the sample specific detection limit.
quantitation_limit	Text(20)		Concentration level above which results can be quantified with confidence
result_unit	Text(15)		Units of measurement for the result
detection_limit_unit	Text(15)		Units of measurement for the detection limit(s). This field is required if a reporting_detection_limit is reported.
tic_retention_time	Text(8)		Retention time in seconds for tentatively identified compounds
result_comment	Text(2000)		Result specific comments
custom_field_2	Text(255)		QC_Flag_1
custom_field_3	Text(255)		QC_Flag_2
custom_field_4	Text(255)		QC_Flag_3
lab_sdg	Text(20)		Sample Delivery Group (SDG) identifier. A single bottle may be assigned to only one Sample Delivery Group (SDG).

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40)	Y	Unique sample identifier. Each sample at a facility must have a unique value, including spikes and duplicates. You have considerable flexibility in the methods used to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS.
lab_anl_method_name	Text(20)	Y	Laboratory analytical method name or description
analysis_date	DateTime	Y	Date and time of sample analysis in 'MM/DD/YYYY HH:MM:SS' format. May refer to either beginning or end of the analysis as required by EPA.
total_or_dissolved	Text(10)	Y	Must be either 'D' for dissolved or filtered [metal] concentration, 'T' for total or undissolved, or "N" for everything else
column_number	Text(2)		Values include either '1C' for first column analyses, '2C' for second column analyses or 'NA' for tests for which this distinction is not applicable.
test_type	Text(10)	Y	Type of test. Valid values include 'INITIAL', 'REEXTRACT1', 'REEXTRACT2', 'REEXTRACT3', 'REANALYSIS', 'DILUTION1', 'DILUTIONS2', and 'DILUTIONS3'
lab_matrix_code	Text(10)		Code which distinguishes between different type of sample matrix. For example, soil samples must be distinguished from ground water samples, etc. The matrix of the sample as analyzed may be different from the matrix of the sample as retrieved (e.g. leachates), so this field is available at both the sample and test level.
analysis_location	Text(2)	Y	Must be either 'FI' for field instrument or probe, 'FL' for mobile field laboratory analysis, or 'LB' for fixed_based laboratory analysis
basis	Text(10)	Y	Must be either 'Wet' for wet_weight basis reporting, 'Dry' for dry_weight basis reporting, or 'NA' for tests for which this distinction is not applicable. The EPA prefers that results are reported on the basis of dry weight where applicable.
container_id	Text(30)		Report as null
dilution_factor	Numeric		Effective test dilution factor
prep_method	Text(20)		Laboratory sample preparation method name or description
prep_date	DateTime		Beginning date and time of sample preparation in 'MM/DD/YYYY HH:MM:SS' format.
leachate_method	Text(15)		Laboratory leachate generation method name or description. The method name should be sufficient to reflect operation of the laboratory.
leachate_date	DateTime		Beginning date and time of leachate preparation in 'MM/DD/YYYY HH:MM:SS' format.
lab_name_code	Text(40)		Unique identifier of the laboratory as defined by the EPA
qc_level	Text(10)		May be either 'screen' or 'quant'
lab_sample_id	Text(40)		Laboratory LIMS sample identifier. If necessary, a field sample may have more than one LIMS lab_sample_id (maximum one per each test event).
percent_moisture	Text(5)		Percent moisture of the sample portion used in this test; this value may vary from test to test for any sample. Numeric format is 'NN.MM', i.e., 70.1% could be reported as '70.1' but not as '70.1%'.
subsample_amount	Text(14)		Amount of sample used for test
subsample_amount_unit	Text(15)		Unit of measurement for subsample amount
analyst_name	Text(50)		Report as null
instrument_id	Text(60)		Instrument identifier
comment	Text(2000)		Comments about the test
preservative	Text(20)		Sample preservative used
final_volume	Numeric		The final volume of the sample after sample preparation. Include all dilution factors.
final_volume_unit	Text(15)		The unit of measure that corresponds to the final_volume
cas_rn	Text(15)	Y	Use values in analyte valid value table
chemical_name	Text(255)	Y	Use the name in the analyte valid value table
result_value	Numeric		Analytical result reported at an appropriate number of significant digits. May be blank for non-detects.
result_error_delta	Text(20)		Error range applicable to the result value; typically used only for radiochemistry results.
result_type_code	Text(10)	Y	Must be either 'TRG' for a target or regular result, 'TIC' for tentatively identified compounds, 'SUR' for surrogates, 'IS' for internal standards, or 'SC' for spiked compounds.
reportable_result	Text(10)	Y	Must be either 'Yes' for results which are considered to be reportable, or 'No' for other results. This field has many purposes. For example, it can be used to distinguish between multiple results where a sample is retested after dilution. It can also be used to indicate which of the first or second column result should be considered primary. The proper value of this field in both of these two examples should be provided by the laboratory (only one result should be flagged as reportable).
detect_flag	Text(2)	Y	Maybe either 'Y' for detected analytes or 'N' for non_detects or 'TR' for trace. Use 'Y' for estimated (above detection limit but below the quantitation limit).
lab_qualifiers	Text(20)		Qualifier flags assigned by the laboratory

Field Name	Data Type	Required	Comment
validator_qualifiers	Text(20)		Qualifier flags assigned by the validation firm.
interpreted_qualifiers	Text(20)		Qualifier flags assigned by the validation firm
organic_yn	Text(1)	Y	Must be either 'Y' for organic constituents or 'N' for inorganic constituents
method_detection_limit	Text(20)		Method detection limit
reporting_detection_limit	Numeric		Concentration level above which results can be quantified with confidence. It must reflect conditions such as dilution factors and moisture content. Required for all results for which such a limit is appropriate. The reporting_detection_limit column must be reported as the sample specific detection limit.
quantitation_limit	Text(20)		Concentration level above which results can be quantified with confidence
result_unit	Text(15)		Units of measurement for the result
detection_limit_unit	Text(15)		Units of measurement for the detection limit(s). This field is required if a reporting_detection_limit is reported.
tic_retention_time	Text(8)		Retention time in seconds for tentatively identified compounds
result_comment	Text(2000)		Result specific comments
lab_sdg	Text(20)		Sample Delivery Group (SDG) identifier. A single bottle may be assigned to only one Sample Delivery Group (SDG).
qc_original_conc	Numeric		The concentration of the analyte in the original (unspiked) sample. Might be required for spikes and spike duplicates (depending on user needs). Not necessary for surrogate compounds or LCS samples (where the original concentration is assumed to be zero).
qc_spike_added	Numeric		The concentration of the analyte added to the original sample. Might be required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample (depending on user needs).
qc_spike_measured	Numeric		The measured concentration of the analyte. Use zero for spiked compounds that were not detected in the sample. Might be required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample (depending on user needs).
qc_spike_recovery	Numeric		The percent recovery calculated as specified by the laboratory QC program. Always required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as percentage multiplied by 100 (e.g., report "120%" as "120").
qc_dup_original_conc	Numeric		The concentration of the analyte in the original (unspiked) sample. Might be required for spike or LCS duplicates only (depending on user needs). Not necessary for surrogate compounds or LCS samples (where the original concentration is assumed to be zero).
qc_dup_spike_added	Numeric		The concentration of the analyte added to the original sample. Might be required for spike or LCS duplicates, surrogate compounds, and any spiked and duplicated sample (depending on user needs). Use zero for spiked compounds that were not detected in the sample. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Also complete the qc-spike-added field.
qc_dup_spike_measured	Numeric		The measured concentration of the analyte in the duplicate. Use zero for spiked compounds that were not detected in the sample. Might be required for spike and LCS duplicates, surrogate compounds, and any other spiked and duplicated sample (depending on user needs). Also complete the qc-spike-measured field.
qc_dup_spike_recovery	Numeric		The duplicate percent recovery calculated as specified by the laboratory QC program. Always required for spike or LCS duplicates, surrogate compounds, and any other spiked and duplicated sample. Also complete the qc-spike-recovery field. Report as percentage multiplied by 100 (e.g., report "120%" as "120").
qc_rpd	Text(14)		The relative percent difference calculated as specified by the laboratory QC program. Required for duplicate samples as appropriate. Report as percentage multiplied by 100 (e.g., report "30%" as "30").
qc_spike_lcl	Text(14)		Lower control limit for spike recovery. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as percentage multiplied by 100 (e.g., report "60%" as "60").
qc_spike_ucl	Text(14)		Upper control limit for spike recovery. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample. Report as percentage multiplied by 100 (e.g., report "60%" as "60").
qc_rpd_cl	Text(14)		Relative percent difference control limit. Required for any duplicated sample. Report as percentage multiplied by 100 (e.g., report "25%" as "25").
qc_spike_status	Text(10)		Used to indicate whether the spike recovery was within control limits. Use the "*" character to indicate failure, otherwise leave blank. Required for spikes, spike duplicates, surrogate compounds, LCS and any spiked sample.
qc_dup_spike_status	Text(10)		Used to indicate whether the duplicate spike recovery was within control limits. Use the "*" character to indicate failure, otherwise leave blank. Required for any spiked and duplicated sample.
qc_rpd_status	Text(10)		Used to indicate whether the relative percent difference was within control limits. Use the "*" character to indicate failure, otherwise leave blank. Required for any duplicated sample.

Field Name	Data Type	Required	Comment
sys_sample_code	Text(40)		Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. The laboratory and the EQuIS user have considerable flexibility in the methods they use to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS.
lab_anl_method_name	Text(20)		Laboratory analytical method name or description
analysis_date	DateTime		Date and time of sample analysis in 'MM/DD/YYYY HH:MM:SS' format. May refer to either beginning or end of the analysis as required by EPA.
total_or_dissolved	Text(10)		Must be either 'D' for dissolved or filtered [metal] concentration, or 'T' for total or undissolved, or "N" for everything else
column_number	Text(2)		Values include either '1C' for first column analyses, '2C' for second column analyses or 'NA' for tests for which this distinction is not applicable.
test_type	Text(10)		Type of test. Valid values include 'INITIAL', 'REEXTRACT1', 'REEXTRACT2', 'REEXTRACT3', 'REANALYSIS', 'DILUTION1', 'DILUTIONS2', and 'DILUTIONS3'
test_batch_type	Text(10)	Y	Lab batch type. Valid values include 'Prep', 'Analysis', and 'Leach'. This is a required field for all batches.
test_batch_id	Text(20)	Y	Unique identifier for all lab batches.

Field Name	Data Type	Required	Comment
file_name	Text(255)	Y	Name of the file.
file_type	Text(20)	Y	Type of the file.
file_date	DateTime		Date of the file.
title	Text(255)		Title of the file.
author	Text(255)		Author of the file.
confidential_yn	Text(1)		Whether or not the file is confidential.
remark	Text(2000)		Remark for the file.
place_type	Text(50)		Type of place this file is associated with.
place_code	Text(50)		Code/identifier of the place this file is associated with.
place_subcode	Text(50)		Subcode/identifier of the place this file is associated with.
external_url	Text(2000)		If the file resides externally, this is the full HTTP URL to the external file. For a file accessible via HTTP/S that will be delivered to the user as an HTTP/S redirect, enter the full HTTP/S URL: http://someserver.org/dir/file1.pdf For a file accessible via HTTP/S that will be delivered to the user proxied through EQuIS Enterprise, enter the full HTTP/S URL preceded by 'proxy.': proxy.http://someserver.org/dir/file2.pdf
content			Content of the file.